

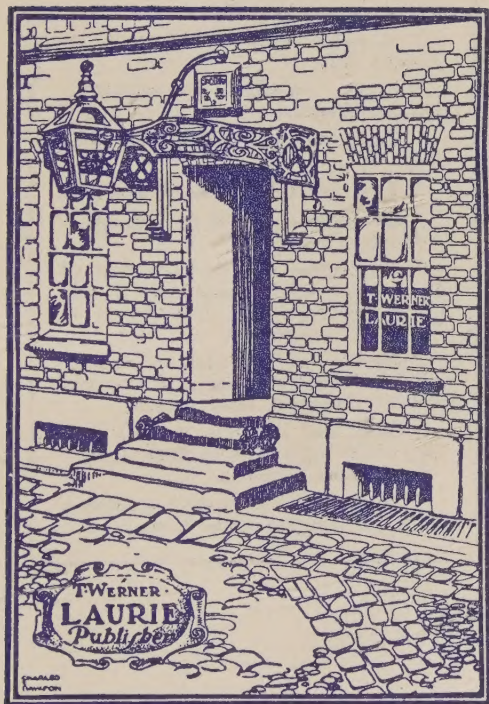
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BRITISH INSECT LIFE



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MEADOW BROWN BUTTERFLY
(*Epinephile jurtina*)

BRITISH INSECT LIFE

A POPULAR INTRODUCTION TO
ENTOMOLOGY

BY

EDWARD STEP, F.L.S.

AUTHOR OF "MARVELS OF INSECT LIFE," "INSECT ARTISANS,"
"WAYSIDE AND WOODLAND TREES," ETC.

WITH 8 ILLUSTRATIONS IN COLOUR BY ALFRED
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PREFACE

THE purpose of the author in writing the following chapters is to enable the Nature-lover, the teacher and the gardener to gain a clear idea of the several types of Insect life that are to be met with commonly in our own country. To this end he has drawn examples from all the Orders into which the classifying Entomologists have divided this great class of animals, and has attempted their description with as little employment as possible of technical language. The majority of popular books on Insects relate almost exclusively to Butterflies, Moths and Beetles; and even among Entomologists the other groups are known as "the neglected Orders." From the present volume, it is believed that those for whom it is intended will be able, at least, to gain an intelligent idea of the types of structure in these Orders and the reasons for their separation, and in a general way to allocate an Insect that is new to them to its proper place in one of these groups.

Seeing that at least twelve thousand species of

British Insects have been named already, no reader will expect to find them all mentioned in this volume; but the majority of the forms that are likely to be encountered in our country rambles, or in our gardens and houses, will be found represented.

With a few exceptions the figures on the black and white plates have been reproduced from the author's photographs; and in this connection he would like to acknowledge his obligations to his friends, Messrs Harry Moore, F.E.S., and A. W. Dods, who placed numerous specimens at his disposal for this purpose; also to Mr C. L. Withycombe, F.E.S., for permission to reproduce his drawing of *Boreus* on Plate 13.

EDWARD STEP

NOTE ON THE COLOUR PLATES

In some of the illustrations to Mr Step's book I have attempted—for the first time, I believe—to depict insects as they actually appear in flight; their wings vibrating with great rapidity. Few of us know the Humming-bird Hawk-moth in repose, though it is well known as an insect darting about and hovering over the flowers in our gardens. Bees are never seen with extended motionless wings except in museums and collectors' cabinets; but we all know them as heavy flying insects which buzz about in our fields, banks and gardens.

In the other drawings I have shown the insects ALIVE, with all that indescribable glow of freshness which is known only to the lover of insects—and which soon fades away when they are pinned out in a cabinet.

ALFRED PRIEST.

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INTRODUCTORY

ONE of the chief difficulties in the way of a proper understanding of Insect life is the loose way in which the word Insect is commonly applied, even by educated persons. The old dictionary definition—"anything small and contemptible"—is still currency of thought, although advanced lexicographers may have ceased to employ it. In consequence, spiders, worms, and centipedes are included in the popular idea of an Insect. So great is the variety of external form among real Insects that it is not easy to define them in a popular phrase.

The fact that we encounter Insects in all stages of their development adds to the difficulty; but when they have arrived at the adult condition we may always be certain of them *by counting their legs*. Whether they are equipped with four wings, two wings, or have no wings at all makes no difference: if they possess six legs and six only we may be sure they are genuine Insects. This test rules out spiders, scorpions, mites, centipedes, wood-lice, and other interesting small fry popularly classed as Insects that we may meet with in the open or the garden. Having satisfied ourselves that any creature under examination has the requisite number of legs, if we look further we shall find that it has three more or less well defined areas—head, fore-body or thorax, and hind-body or abdomen.

The head, of course, carries the masticatory apparatus, normally including three pairs of jaws; also a pair of antennæ or feelers, and two large compound eyes—that is, eyes with a great number of separate lenses or facets crowded together. There are, in addition, three small, simple eyes,

which are usually overlooked by the casual observer. Attached to the fore-body are the three pairs of legs, and normally two pairs of wings. But the first pair of wings may be modified to form protecting covers (elytra) for the second pair, as in Beetles, etc., or the second pair may be so reduced (Flies) as to function no longer as flight organs; or all the wings may be absent, as in Fleas and Springtails. In the adult Insect the hind-body bears no legs; but the hinder segments or rings sometimes bear tails (*cerci*) or stylets.

Insects have no bones or other internal hard parts: the skeleton being worn outside in the form of armour-plating. This takes the shape of a number of thin plates of a horny substance called chitin, developed between the upper and the lower skins. At the junction or overlapping of two segments the skin is left soft, thus allowing freedom of movement of the several parts, particularly at the joints of the limbs. The body as a whole may be curved either horizontally or vertically. In the larval stage Insects are, as a rule, only partially protected by this hard substance, the head, jaws and tips of the limbs of caterpillars being strengthened by it. In the pupal stage its presence is more general, and the pupæ of Moths and many Flies have a continuous coating of chitin. In the Cockroaches, Crickets and Bugs, however, it forms a general armour throughout life.

To this external skeleton (*exoskeleton*) the muscles are attached, and under its firm roof all the delicate internal organs are protected. Insects lack the padding of firm flesh by which similar organs are retained in position in the back-boned animals; here the office is performed by webs and bundles of muscle fibres, which are concerned chiefly, of course, in effecting the movements of

the limbs, jaws and body segments, the contraction and dilatation of the heart, the air-tubes, etc.

The position of some of the organs is not the same as we are accustomed to find in studying the anatomy of the back-boned creatures. The heart lies along the entire length of the back, the nervous system along the lower internal surface, and the alimentary system takes a middle course between these two. The heart is made up of a number of chambers with valve connections and valved side-openings; but on leaving the heart the blood is not confined to a system of tubes but flows at large through all the spaces of the body. Commencing at the rear, all the chambers contract in turn, forcing the blood out in the head region. The emptied chambers equally in turn then admit blood through their side valves. There is no passage through lungs for its oxygenation, for the Insect has no lung; but a system of tubes with openings (*spiracles*) along the sides of the body permeates the remotest parts, and the free blood bathing their walls takes up oxygen through their delicate tissues. In connection with the spiracles there are valves which are closed or opened to regulate the change of air in the tube system when it has been deprived of its oxygen and loaded with carbonic acid. The air-tubes are kept open in spite of the pressure upon them, by means of spiral chitinous threads, which have been copied by man in the spiral wire which prevents the collapse of india-rubber gas tubes. In some Insects the vital fluid is colourless, in others red, green or violet.

The nervous system consists of two parallel cords connected at intervals by knots or nerve-centres (*ganglia*) from which delicate nerve-threads radiate to the sense-organs, limbs and muscles. In the head a coalescence of ganglia constitutes a brain

which controls the eyes and antennæ, whilst a supernumary brain behind the gullet sends off nerves to the jaws and other mouth-parts. Other nerve-centres in the fore-body control the legs and wings, and there are similar ganglia in most of the segments of the hind-body. In the higher types of Insects we find a tendency to greater fusion of these nerve-centres; whilst, conversely, in the primitive forms they are more distinct.

In addition to the eyes, already mentioned, the head of the Insect bears other sense-organs. The antennæ or feelers contain organs of smell, in the form of pits filled with fluid and connected with nerve terminations. Similar pits on certain of the mouth-parts—differing in the numerous species—have been identified as organs of taste. The organs of hearing are situated in various parts of the body, according to species. In some Gnats and Midges they are found in the second joint of the antenna; but in some of the two-winged flies they have been detected in the “balancers” which represent a second pair of wings. In the short-horned Grasshoppers (including Locusts) they are sunk in the first segment of the hind-body; whilst in the long-horned Grasshoppers and the Crickets they are contained in the shanks of the foremost pair of legs. Insects appear to feel through the medium of hairs which penetrate the armour of various parts—especially on the antennæ and mouth-feelers—and are connected at their base with nerve-endings.

The alimentary system occupies the centre of the body from the mouth to the hinder extremity, with several coils, and is more or less complex in different species. In its most developed forms it includes a crop, gizzard, stomach, kidney-tubes and an intestine.

The cycle of Insect life begins with the egg.

There is no uniformity either in size, shape, colour or ornamentation of these eggs, or in the manner of their deposition. Under low powers of the microscope they exhibit beautiful forms and exquisite sculptural designs. Those of the Cockroaches and Stick Insects are protected by outer capsules; those of the Green Lacewing-fly are mounted on long stalks, reminding one of the coco-nuts balanced on tall sticks at fairs; Gnats cement theirs to form a boat-shaped mass that floats on the water; Caddis-flies' eggs are associated in a long cylinder of jelly, and some of the Water-beetles enclose theirs in a papery bag. Some are buried in the earth; others inserted in slits specially cut for them in vegetable tissues. In some cases the embryo is furnished with a head-spine for piercing the egg-shell. Some female Insects retain their eggs until they are hatched—such as Flesh-flies and Plant-lice; whilst some eggs laid in summer and autumn do not hatch until the following spring.

The familiar term metamorphosis in connection with Insect development does not apply with equal force to all the groups. Some Insects when they leave the egg are already of the same form as their parents, minus wings—such are Springtails, Grasshoppers, Cockroaches; or they may be utterly unlike, such as the caterpillars of Moths and Butterflies, the grubs of Beetles, and the maggots of Flies. Where the young resembles the parent it is known as a *nymph*, and it is active throughout life; but caterpillars, grubs and maggots are known in general terms as *larvæ*, and later pass into a resting stage in which they are known as *pupæ* or chrysalids. The fully developed Insect of any kind is known as an *imago*.

According to their similarities of structure and development, Insects are grouped by naturalists

into genera, families and orders; but as our ideas of affinity are subject to modification consequent upon accessions to our knowledge, these groupings are by no means fixed and immutable; and whereas some authorities are content to class all known Insects in a dozen orders, others demand twice that number of compartments. It is not intended, therefore, to launch the reader upon that somewhat troubled sea. Broadly speaking, however, there is tolerable agreement over the most generally studied groups, and these have been selected for consideration in the pages following. The scale-clad-winged Butterflies and Moths constitute the order Lepidoptera; the Beetles are Coleoptera; Dragon-flies Odonata; Lacewings and Alder-flies are Neuroptera; two-winged Flies are Diptera; the four-winged Stinging Insects such as Bees, Wasps, Ants and Ichneumons are Hymenoptera; the Bugs Hemiptera; the Earwigs, Grasshoppers and Cockroaches are Orthoptera. The sequence of these orders followed in technical works is not adopted here, because this is intended as a popular work, and in consequence what the writer has considered a more popular arrangement has been made. Systemists differ widely in their views; and whilst one will give the nine orders adopted in this page another splits them into twenty-four. The proper arrangement of the groups described in the following chapters would be after this manner: 1 Wingless Insects (*Aptera*), 2 Grasshoppers, Earwigs, etc. (*Orthoptera*), 3 Stone-flies and Bird-lice (*Platyptera*), 4 Mayflies (*Plectoptera*), 5 Dragon-flies (*Odonata*), 6 Thrips (*Thysanoptera*), 7 Bugs (*Hemiptera*), 8 Lacewing-flies and Scorpion-flies (*Neuroptera*), 9 Caddis-flies (*Trichoptera*), 10 Butterflies and Moths (*Lepidoptera*), 11 Beetles (*Coleoptera*), 12 Flies (*Diptera*), 13 Bees, Wasps, etc. (*Hymenoptera*).



DRAGON-FLY
(*Zygoptera vivida*)
resting on Iris leaves

By using (2.10) and (2.11) we obtain

BRITISH INSECT LIFE

BUTTERFLIES

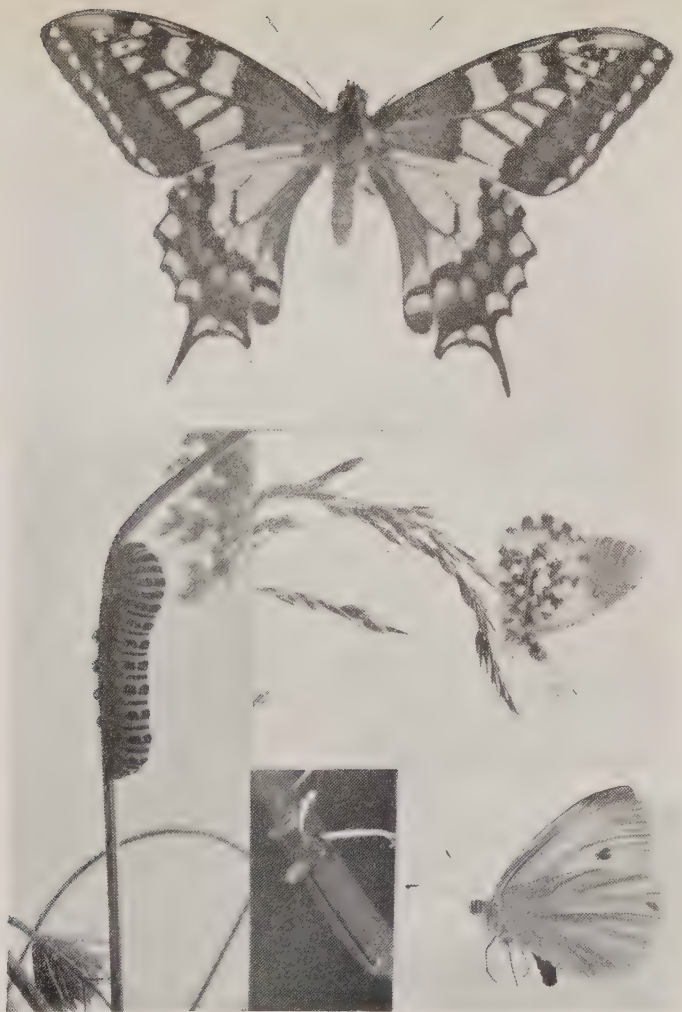
WHEN the word "Insects" is mentioned, one naturally thinks at once of Butterflies, the gayest and most strikingly beautiful of the race. Because of their beauty they are, with two exceptions, exempted from the almost universal detestation of their class. Poets and painters have made them their darlings; and in their marvellous transformation from a "grovelling worm" to an ethereal rainbow-hued spirit the ancients saw a fitting emblem of the soul freed from its earthly trammels. Much of the Butterfly's popularity is due probably to the fact that the average person does not know anything against it as a despoiler of property, the exceptions noted above being the two Garden Whites (Large and Small) which are known to all gardeners as the vermin whose caterpillars reduce the cabbage patch to a collection of ghastly skeletons when it should be filled with portly Savoyes, Drumheads and Oxhearts.

"Fine feathers make fine birds," but the naturalist in compiling his tables of relationships and precedence gives heed more to structural organisation and intellectual qualities. He gives pride of place among Insects to the Bees, Wasps, Ants and their kindred; but as this is a popular rather than a scientific work, we are free to begin our account with the more familiar Butterflies.

The popular distinction between Butterflies and Moths is one that can scarcely be upheld on scientific grounds, for there is no fundamental difference between the two groups of Insects with scale-clad wings. In all essential details they have the same structure, the same life-cycle, and similar habits. They all originate from eggs which they quit in the form of tiny caterpillars, and feed as a rule on leaves or wood. They cast their skins five times before completing their larval growth (each intervening stage being known as an instar), and the throwing off of the last caterpillar skin discloses the chrysalis or pupa. In this third condition the Insect is limbless, but the outlines of its future legs and wings can be discerned through the firm skin. With few exceptions, the caterpillars of the British Butterflies do not spin cocoons, so that the chrysalis, suspended to a little pad of silk by means of hooks at the extremity of the hind-body, and perhaps a slight silken girdle, is fully open to inspection. The portion of the chrysalis bearing these hooks is known as the cremaster.

The reason for the helpless, inactive stage represented by the chrysalis is that the future life of the Insect is to be entirely different from that of the caterpillar stage. The cutting jaws of the latter have to be got rid of, and a new form of mouth presenting some resemblance to the trunk of the elephant has to be substituted, to enable the Butterfly to suck up liquid food. A different set of internal organs has to be formed to meet this change of diet, and to provide for the reproduction of the species; and the old internal structure has to be broken down in order that the new organisation may be built up from it. It is not merely a metamorphosis, but a re-birth.

Let us take the four distinct periods of the



To face page 16.

BUTTERFLIES.

- 1 Swallow-tail. 2 Swallow-tail caterpillar. 3 Orange-tip.
4 Egg of Orange-tip, enlarged. 5 Small Garden White.



To face page 17

BUTTERFLIES.

- 1 Clouded Yellow. 2 Brimstone. 3 Brimstone caterpillar.
4 Brimstone chrysalis. 5 White Admiral. 6 Small
Tortoiseshell.

Butterfly's life, glancing at them in order. The eggs, which all have distinct, firm shells, vary between species and species, their forms being more or less globular, nine-pin-shaped, cheese-shaped or elliptical; in the Blues the form is that of a round hassock. All are symmetrical; and their outer surfaces are pitted, or have raised patterns of strong ribs, flutings or network. They differ in colour also, and in this connection often show changes of tint as they progress towards hatching. They are deposited on or very near to the plant which is the favourite food of the caterpillar of the particular species: in some cases singly, in others in batches. When the minute caterpillar is ready for hatching, it bites through the shell and makes its escape. In many cases the egg-shell is consumed entirely before the caterpillar makes its first attack on a leaf.

As a rule the caterpillar is cylindrical, and the entire body consists of fourteen segments, of which the first is the head. The three immediately succeeding, which each bear a pair of legs, correspond with the fore-body (*thorax*) of the mature Insect, and the remaining ten constitute the hind-body (*abdomen*). It should be explained, however, that on external examination without dissection only nine segments can be counted in the hind-body. This is due to amalgamation or telescoping in the two final segments. Segments three to six of the hind-body bear each a pair of soft, temporary legs (prolegs), and a similar pair (claspers) will be found on the last segment. These are for walking purposes—the true legs performing the function of hands—and the base of each bears a series of hooks which enable them to take very firm hold. On the flanks of all these segments, except the head and that immediately following it, there is a spiracle

or opening admitting air to the elaborate system of air-tubes referred to in our introductory chapter. With the aid of a pocket-lens—in a few cases without—two longitudinal rows of slight elevations may be made out along the upper surface, and three similar rows along each side of the caterpillar. These are the supports from which spring hairs or spines.

The head has a hard coat of chitin, and bears on each side of the jaws a cluster of five small simple eyes (*ocelli*). With the aid of the lens the short antennæ or feelers may be seen also, with the central mouth-parts adapted for cutting and breaking down the caterpillar's food. A minute projection from the lower lip is the spinneret through which on occasion is paid out the special fluid which hardens at once into the gossamer threads that caterpillars find so useful. The young caterpillar's first ecdysis or change of skin takes place within a few days of its leaving the egg, and the other moults take place at varying intervals.

When the caterpillar's final ecdysis has disclosed the chrysalis, the wings, limbs and antennæ appear to be free whilst the creature is moist; but exposure to the air causes this moisture to harden rapidly into a glossy envelope which fixes all the parts securely. Before the caterpillar changed into the chrysalis condition it made some preparation by spinning a tiny pad of silk threads from which the chrysalis may be suspended by its tail. The caterpillar hangs to this by its hind claspers, and when its last skin is shed the soft chrysalis holds on to the latter by a pair of pincers until it can reach up above the old skin and fix the hooks of its cremaster in the silk. Some Butterfly chrysalids hang head downwards from the under side of a leaf; but others, such as the Swallow-tail and the Whites, have the

head upwards, and the caterpillars make arrangements for further support by spinning a few strands of silk across their middle which acts as a supporting girdle for the chrysalis.

The process of development having sufficiently advanced, the skin of the chrysalis splits over the head and fore-body, and the Butterfly walks out. At this moment its wings are small, flabby and crumpled, but as the Insect takes up a position in which the wings hang downwards, these quickly expand and attain their proper size and form, and then harden; so that in the course of a few hours the fully grown Butterfly is able to indulge in its first flight.

If we have for the first time been rearing Butterflies by obtaining the eggs or caterpillars and making observations on the latter stage, we shall be interested in tracing in detail the series of changes that are now complete. The wings are a feature entirely new, of which there was no hint in the caterpillar. Between the upper and lower skins of which each of the four wings is composed there are strong fibres traversing the wing, giving it rigidity. These fibres are spoken of generally as veins or nervures. Although these words are convenient and fairly expressive they are quite inaccurate, as the structures they refer to are in no sense analogous to the veins or nerves of the back-boned animals. Over the surface are laid many thousands of microscopic scales (really modified hairs) which form the colour patterns of the wing—some by actually containing pigment, others by the delicate sculpturing of the surface reflecting special rays of the light around us. These scales vary much in form in different species, and even on different parts of the wing in any species. These wings are all attached to the fore-

body by their narrowed bases, and are controlled by powerful muscles situated in this region.

Other most conspicuous changes are found in the head-region, of which the most striking features are the large protuberant compound eyes and the long many-jointed feelers or antennæ. In the caterpillar the latter were quite minute and had to be looked for; in the Butterfly they may be a half or two-thirds of the length of head and body. They are variously thickened at the extremity, and are considered to be important sense-organs, particularly of smell. Then there is the long hollow proboscis, already alluded to, consisting of two half-tubes representing the jaws of higher animals, which completely interlock by their edges but can be separated readily for the purpose of cleaning. Consisting of many rings, this proboscis, often of very great length, is coiled up like a watch-spring when not in use, or extended so as to reach the nectaries of tubular flowers, whilst a sucking chamber in the head enables it to draw up the fluid sweets it finds in the flower. Concerning the compound eyes with their many facets, it should be explained that each facet has a separate lens which throws an image of surrounding objects. The structure of the compound eye is rather complicated, and it would be foreign to the purpose of this book to enter upon a description of it. For nearly a hundred years the theory of Müller that Insects with compound eyes could only perceive a mosaic image held sway—that is, that the picture seen was broken up into little bits, as we behold an artist's design wrought in bits of coloured glass or enamel. Quite recently (1918) Eltringham has proved that this is all wrong, and that a Butterfly can see much as we see—a continuous picture—though its range of vision is much more restricted than ours.

We have sixty-eight separate species of Butterflies in Britain, several of them no doubt owing their persistence to reinforcements by migration from the Continent. These sixty-eight represent six distinct families of the order Lepidoptera; and we will consider them briefly in these family groups.

The well-known, but extremely local, Swallow-tail (*Papilio machaon*) is one of our largest Butterflies, the fore-wings having an expanse of three inches, and the hind-wings being extended backwards into the characteristic long, slender tail. All the wings have yellow for the ground colour, framed, barred and veined with black; the band across the hind-wings bears six spots of blue, and the "eye-spot" at its inner end is red bordered with blue above. The male differs from the female in being somewhat smaller. Although a common and generally distributed species on the Continent, in this country it is all but restricted to the fens of Cambridgeshire and Norfolk, where the globular eggs are laid on the Milk Parsley, which is the chief food of the caterpillar. The latter is a handsome green creature with every ring of its body banded with black which bears orange spots. From a fold of the skin just behind the head, when the caterpillar is annoyed—as by Ichneumon-wasps—a forked pink process is extruded, which gives off a strong odour. The chrysalis, which is dull yellow-green in colour, is usually attached to reeds, head upwards with a girdle round the middle. From some of these the Butterflies break forth in August, but others pass through the winter as pupæ and emerge in the winged condition in the May or June following. It is the sole representative in this country of the large family Papilionidæ.

Of the next family, the Pieridæ or Whites, we

have ten native species, of which, however, two are very rare—one of the two, the Bath White, being in fact only an occasional visitor to this country from the Continent. Of the other eight several species are among our most plentiful Butterflies. Among these is :

The Large White (*Pieris brassicæ*) the larger of the two white Butterflies that are so fond of visiting our gardens, where their caterpillars perpetrate terrible havoc, especially in that portion devoted to the raising of our green food. All the wings are white, but the tips of the fore-wings are black. The female in addition has two black spots a little to the outside of the middle of the wing and a bar of the same colour in the middle of the lower margin, which may or may not be connected with the lower of the two spots. On the under side the black of the tips is replaced by yellow, and in both sexes there are black spots corresponding with those on the upper side of the female. The hind-wings are yellow beneath. There are two broods in the year, the Butterflies that appear in the spring being characterised by a greyish degradation of the blacker wing-tips usual in the summer brood. The yellow nine-pin-shaped eggs are laid on the cabbage-leaf in batches of a few up to a hundred, and the young caterpillars hatch out about a week later. They grow to a length of an inch and a half, and are greenish with yellow lines and black spots. They give out a strong and unpleasant odour which—together with the “warning” colours, black and yellow—protects them from the attack of birds. But the evil smell does not ward off the attacks of Ichneumon-wasps, which reduce their numbers greatly. The chrysalis is pale grey streaked with yellow and sprinkled abundantly with spots and dots of black. It stands head upwards against a

wall or fence, the tail end hooked in a pad of silk and a slight girdle around the middle. In most years our home supply is supplemented by swarms of the Butterfly from the Continent; otherwise we might not be able to reckon this species as a British Insect, for our winters are too severe usually for the chrysalis to come through.

The Small White (*Pieris rapæ*) is in appearance very like the Large White, but about one-third smaller. Popularly, it is regarded as a *young* example of its larger relative. There are both spring and summer broods as in the last species, the spring brood having paler tips to the wings than those of the summer brood. The caterpillar is smoother, more downy, of a bluish-green tint, with a yellow line down the middle of the back and the sides with a line of yellow dots. It feeds on cabbage and related plants, and shows a strong liking for mignonette and tropæolum. The chrysalis varies in tint from greenish grey to pale brown, faintly dotted and lined with black.

The Green-veined White (*Pieris napi*) is very similar to the Small White, but on the under side, especially of the hind-wings, the nervures are overlaid with grey scales producing in combination with the yellow a greenish appearance. The caterpillar is green above and pale grey beneath, the back dotted with raised black spots which support short hairs. The middle line is dark, and a line of yellow runs along each side. It feeds upon Jack-by-the-Hedge and allied plants, on which the eggs are laid singly throughout the summer.

The Bath White (*Pontia daplidice*) has the black markings of the upper side broken up and producing a chequered effect, whilst the under side is mottled with greenish yellow.

The Orange-tip (*Euchloë cardamines*) is a smaller

species, with a black or blackish tip to the fore-wings and not far from their front margin a single black spot. In the male a broad band of orange joins the black tip. The under side of the hind-wings is chequered with green, and the pattern shows faintly through to the upper side. A single egg is laid on the upper part of Jack-by-the-Hedge, Cuckoo-flower or other wild crucifer, about June, and is at first white but becomes orange. It is elliptical in shape and stands on end. As a rule only one egg will be found on a plant. The full-grown green caterpillar with a white line down each side closely resembles the seed-pod upon which it feeds, biting through immediately above a seed and eating it out. The greyish or green chrysalis is of a singularly long and slender form, and when seen from the side is almost crescent-shaped. The Butterfly is one of the most charmingly conspicuous features of the spring along green lanes and the edges of woods.

The Wood White (*Leptosia sinapis*) is of similar proportions to the Orange-tip. It is white with a squarish mark at the tip of the fore-wings, more or less black in the male, but faint and greyish in the female. The Insect is very restricted in its range in this country—chiefly in the western half of England and Ireland—but in appropriate districts its pale yellow egg, green caterpillar and green chrysalis may be found on the Birds'-foot Trefoil and the Meadow Vetchling.

The Clouded Yellow (*Colias edusa*) exhibits a similarity of marking to that of the Large White, but the black of the wing-tips extends as a broad border all down the outer margin of the wings, and the white ground colour has been turned to orange. There is a single black spot on the fore-wing, and near the centre of the hind-wing there is a larger

orange spot clear of the dark suffusion surrounding it. As a rule female examples may be known by the black border being spotted with yellow. It is a spring and autumn Butterfly, the spring brood being augmented in some years by large migrations from the Continent, and this, of course, greatly affects the numbers of the autumn brood, as the visitors come to deposit their elliptical eggs in our fields of clover, lucerne and melilot, upon which the black-dotted, green caterpillar feeds. The yellowish-green chrysalis is rendered distinct from those of its relations by the proportionately large size of the more deeply tinted wing-cases.

The rare Pale Clouded Yellow (*Colias hyale*) is very similar to the foregoing, but the ground colour of the male is a beautiful primrose tint, and that of the female almost white. The caterpillars of the autumn brood attempt to pass through the winter in that stage, but as a rule our climate spoils the experiment, and but for occasional migrations from the Continent *Colias hyale* would disappear from the British fauna lists.

The Brimstone (*Gonepteryx rhamni*) is one of the most familiar of native Butterflies, owing to its habit of passing the winter in the winged state, and emerging from its hibernaculum as soon as a little mildness and bright sunshine tempt it. The bright primrose colour of the wings, without marks save a single spot of orange in the centre of each, combined with the slightly hooked tip of the forewings, the short tail to the hind-wings and the redness of the antennæ, serve to mark this Butterfly as distinct from all other British species. The pale green or yellow egg is laid on the under side of buckthorn leaves (both species), where later the smooth blue-green caterpillar may be found resting on the glossy upper side, where it has spun a mat of

silk to secure firm foothold. The green chrysalis hangs from the under side of the leaf, and its swollen wing-cases, when viewed from the side, give the chrysalis the appearance of a miniature bird in flight. The Butterfly emerges in August.

The next family, the Nymphalidæ, includes nearly a half of our Butterfly list, including the brilliant Admirals and Fritillaries, and the more sombre-tinted Ringlets and Heaths. At the head of them comes the magnificent Insect to which the old Aurelians accorded imperial rank :

The Purple Emperor (*Apatura iris*) is a noble creature whose large wings have an expanse of three inches and are coloured a rich dark brown, spotted and barred with white. There is an eye-spot in the angle of the hind-wings ; and in the male the wings are shot with a blue sheen only visible from certain angles of vision. But the under side, from its marbling of black, white and browns is more strikingly beautiful than the upper. The boldly ribbed green eggs are laid on sallow in August. The strangely shaped, shagreened, green caterpillar when viewed from above is slug-shaped—an appearance helped by a pair of frontal horns and a horizontal tail-like growth behind. Two short whitish lines run from the horns along the back, and there are six or seven oblique lines of similar tint along each side. The caterpillar hibernates and resumes its feeding in spring, changing to the white-streaked, greenish chrysalis in June. The Butterfly emerges in the following month, and must be sought in the larger oakwoods of the southern half of England only. It shows a strong liking for carrion, which is frequently used for its capture by collectors.

The White Admiral (*Limenitis sibylla*), though quite distinct from the Purple Emperor in its

colour and markings, is yet sufficiently like it to suggest an abridged edition. The wings are a rusty-black broken by an irregular and interrupted band of white crossing them from front to back, as shown in the photograph. As in the Emperor, the under side is more beautifully decorated than the upper, the colour being brown banded with white and clouded and dotted with a darker brown. The mature caterpillar is green, darker on the back, dotted with yellow and with a yellow line along the sides. It is sparingly covered with bristly spines of a reddish tint; and it feeds upon honeysuckle and sallow. For hibernation it spins together the edges of a leaf and attaches the footstalk of this to its twig by silk threads, so that the leaf cannot fall with its fellows. The beautiful chrysalis, which hangs head downwards from a leaf, is of a brownish ground tint, blotched with green and gold. A singular appearance is given by a pair of long ear-like prolongations from the head. The Butterfly appears in July, but like the Emperor is restricted to the southern half of England.

The Comma (*Polygonia c-album*). Any person unacquainted with our native Butterflies who should see the Comma settle might be excused for imagining that it had been overhauled by sparrows who had left the imprints of their beaks in the margins of the apparently tattered wings. But this is a bit of Nature's camouflage. In a moment the Butterfly erects its wings over the back, showing the cloudy mottling of browns, grey and green on the under side, where there is a white mark from which the Insect gets its name, resembling as it does a written comma or the letter *c*. So seen, the Butterfly is a broken, withered leaf. On the upper side the wings are tawny with a fairly broad margin of dark brown along the outer margins. On the front

margin are three large black spots whereof two are more or less blunt-wedge-shaped and the other dumb-bell-shaped. Several other black spots are scattered about the wings, and the marginal band of the hind-wings bears five or six spots of the ground colour. Formerly more widely distributed, the Comma is almost restricted in the present day to the shires of Hereford, Worcester, Gloucester and Monmouth. The spiny caterpillar is grey marked with black, except the back behind the sixth ring, which is whitish. It feeds on hop, nettle and red currant. The Butterfly appears in July and soon goes into hibernation, reappearing in spring to lay eggs which hatch in the earlier half of May, and the caterpillars are full-grown late in June.

We have two Tortoiseshell Butterflies—the Large (*Eugonia polychloros*) and the Small (*Aglais urticæ*)—which are marked in very much the same pattern, but the Larger Tortoiseshell has the outer margins of the wings more distinctly scalloped and the ground colour a dull pale brown, whilst in the Smaller Tortoiseshell it is a brighter red-orange, the dark border is dotted with small blue crescents and the basal portion of all the wings is clouded with blackish brown. There is a difference in the food plants of the two species, for whilst the Large Tortoiseshell caterpillars feed on elm, and occasionally other trees, those of the Small Tortoiseshell eat stinging-nettles.

The Peacock Butterfly (*Vanessa io*) needs no detailed description, for the eye-spot on each mahogany-coloured wing recalls the similar marks on the train-feathers of the bird from which it takes its name, and distinguish it from every other British species. The white-dotted, black, spiny caterpillars feed in company on stinging-nettle, where



RED ADMIRAL
(*Vanessa atalanta*)
feeding on Linchome

By kind permission of Hamish Nicol, Esq

later the partially gilded chrysalis may be found suspended. The Butterfly appears about August.

The fine Insect known as the Camberwell Beauty (*Vanessa antiopa*) got its name from examples obtained in this congested London district when it was an outlying rural village; but as a rule the specimens captured in this country have migrated from the northern parts of the Continent, where it is abundant. The wings are chocolate-coloured with a border of pale yellow or white, inside which is a line of small blue spots. The red-spotted, black, spiny caterpillar feeds upon willow and sallow, and the black and orange chrysalis has a whitish "bloom" all over it. Migrant Butterflies arrive here in spring or autumn, and from their eggs the perfect Insects appear in July.

Another beautiful Butterfly whose numbers here are largely augmented by migrations from the Continent is the Painted Lady (*Pyrameis cardui*). In some years it comes over in vast swarms, and when the Butterfly is seen here in May or June, it may almost certainly be assumed that it did not pass through its caterpillar stage in this country. The ground colour is a variable orange, heavily blotched and spotted with black, the black tips to the forewings spotted with white. The decoration of the under side is more beautiful than that of the upper side. The spiny grey caterpillar feeds chiefly upon thistles, often spinning the edges of the leaf together to form a sort of tent in which to feed. The greyish chrysalis is more or less embellished with metallic spots.

The Red Admiral (*Pyrameis atalanta*) is a more regularly conspicuous Butterfly in Britain, though there is reason to believe that our home products are at times reinforced by continental visitors. Like the Peacock, its markings are of such a

character that it is distinct at a glance from all other native species. Its conspicuous features are a diagonal band of scarlet across the black fore-wing with half a dozen spots of pure white above it, and a black dotted band of scarlet on the outer margin of the hind-wing. The variable dark-hued, spiny caterpillar has yellow lines along its sides. It feeds on stinging-nettle, and spins leaves together to make a shelter; and under this the grey and gold chrysalis may be found suspended in July. The Butterfly emerges in July or August, and is in evidence up till October or November, when it swarms on ivy-blossom, and earlier may be found sucking at over-ripe and broken plums. Like the Painted Lady, it often flies at night.

We have nine species of Fritillaries, all of a similar type of markings, but differing in size and coloration. All have spiny caterpillars, and the chrysalids, which are always suspended by their tails, are sometimes embellished with metallic gilding. The first six species feed upon the wild violets, including pansy. The general ground colour of the perfect Insect is a dull brownish-yellow, liberally sprinkled with black spots of variable form and size. The largest species is the Silver-washed Fritillary (*Dryas paphia*) with a spread of wings of two and a half inches. The "silver-wash" takes the form of streaks and splashes on the under side of the hind-wings. The High Brown Fritillary (*Argynnis adippe*) is a good deal smaller, though the span of the wings is only a quarter of an inch less. The markings of the brighter upper side are similar to those of *D. paphia*, but the silvery marks of the paler under side are spots instead of broad streaks. The Dark-green Fritillary (*Argynnis aglaia*) is of similar proportions and markings to the last named; but the under side of the hind-wings

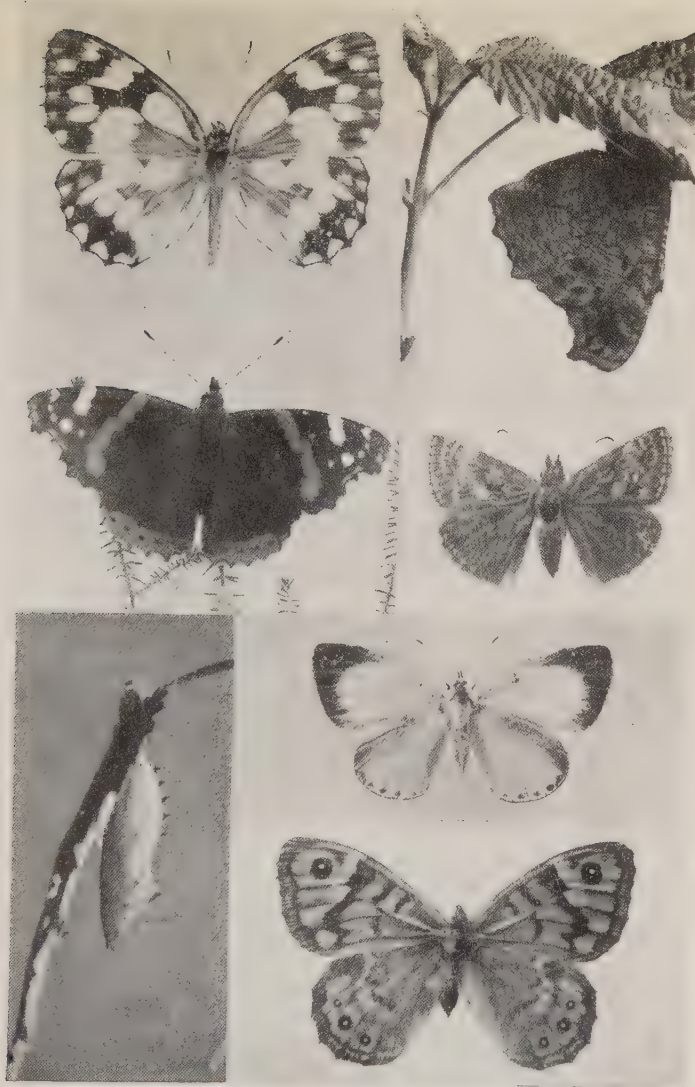
is greenish with silver spots. The Queen of Spain Fritillary (*Argynnis lathonia*) has a more angular outline to the wings than in either of our other species, and the black spots are more equally distributed over the wings. The silvery spots on the under side are very large and striking. The Pearl-bordered Fritillary (*Brenthis euphrosyne*) is, in general appearance, very similar to the High Brown, but little more than half its size. On the under side, however, the pattern is very different, a sequence of seven pearly spots constituting the border of the hind-wing that has suggested the name. There is a similar pearly spot at the base of the wing, and half-way between base and border an elongated patch of the same colour. There is little difference in size between this and the Small Pearl-bordered Fritillary (*Brenthis selene*), but in the latter the tints are darker and the black spotting heavier. On the under side there are three large pearly marks across the centre of the hind-wing.

The Pearl-bordered Likeness or Heath Fritillary (*Melitæa athalia*) is somewhat smaller, the ground colour is deeper, the dark markings are much more connected and really cover more of the upper side area than the ground colour. On the under side the black markings are finer, the ground colour bright fulvous with pale yellow spots arranged in three bands. The caterpillar feeds chiefly on cow-wheat, and occasionally upon woodsage and foxglove. It is found in only a few English counties, and at Killarney in Ireland. In the Glanville Fritillary (*Melitæa cinxia*) of similar proportions there is a more equal balance of light and dark markings on the upper side, whilst on the under side there is considerable suppression of the black lines and greater confluence of the pale yellow spots into black-out-

lined and spotted bands. The caterpillar feeds on the ribwort plantain. It appears to be restricted now as a British species to the Isle of Wight. The remaining species, the Marsh Fritillary (*Melitæa aurinia*), is a brighter looking Butterfly owing to the presence of bands of yellow spots and a border of yellow crescents on the hind-wings. On the under side the fulvous ground colour is spotted with black-edged yellow, and a curved line of small yellow spots have a black dot in each. The caterpillar feeds on the devil's-bit scabious, but though the plant is common generally, the Butterfly is very local.

A fine handsome Butterfly that would be welcomed to a permanent place in the British lists is the Monarch or Milkweed Butterfly (*Anosia plexippus*), a North American species that makes its appearance here in autumn, from time to time, but only singly or in very small numbers. Its proportions are greater than those of any truly native species, the spread of the fore-wings being little less than four and a half inches. The ground colour is orange-brown heavily margined with black and the nervures strongly drawn in black, especially so on the fore-wings. The black border bears a double row of small white dots. The striking caterpillar—which has not yet been found in this country—is white with black and yellow cross stripes, and a pair of slender black “horns” near each end of the body.

The Marbled White (*Melanargia galathea*) again is a Butterfly that needs no detailed description, the photograph reproducing all its colour except that the ground tint may be a creamy white instead of pure white. The under side is a repetition of the upper side pattern, but the black is weaker and in part replaced by yellow-grey. The pale



To face page 32.

BUTTERFLIES.

- 1 Marbled White. 2 Peacock, underside. 3 Red Admiral.
4 Dingy Skipper. 5 Peacock chrysalis. 6 Holly Blue,
female. 7 Wall.



To face page 33.

MOTHS.

- 1 Death's-head Hawk. 2 Lime Hawk caterpillar. 3 Puss-moth. 4 Puss-moth caterpillar. 5 Buff-tip.

brownish caterpillar has a deeper brown line along the middle of the back, and the body bears behind a pair of pinkish tail-like points. It feeds on various grasses. It does not occur in Scotland or Ireland, and is most plentiful in the South of England, especially on chalk-hills.

The following ten species are remarkable for the absence of any brilliant colours, the prevailing tints being ochreous, some shade of brown or black. The caterpillars all feed on grasses.

The Small Mountain Ringlet (*Erebia epiphron*) is a small Butterfly, found only at elevations from about one thousand five hundred feet upwards, in the English lake district, in Scotland and rarely in Ireland. The wings are smoky brown, broken only by a band of tawny spots with black "pupils" near the outer margins. The drab-coloured, bristly caterpillar feeds on hair-grass and meadow-grass. The Grayling (*Hipparchia semele*) has blackish brown wings with an irregular ochreous band near the margin, which is brighter and more sharply defined in the female than in the male. On this band are two white-pupilled black spots on the fore-wing and a smaller one on the hind-wing. The drab caterpillar is mottled and striped with brown. The Butterfly affects dry sloping fields, heaths and downs. The Speckled Wood (*Pararge egeria*) is a much brighter Insect, the dark brown ground colour being relieved by oval and angular spots of yellow. Near the apex of the fore-wing there is a white-pupilled black spot, and two or three similar spots on the hind-wing. The green caterpillar is marked with darker lines. The Wall (*Pararge megæra*) has a similar type of ornamentation, but the ground colour is bright fulvous mapped out into more or less rectangular spaces by dark brown lines and bands. There is a white-pupilled black

spot at the apex of the fore-wing, and four such spots bordering the hind-wing. The pale green, bristly caterpillar is dotted with white. The Meadow Brown (*Epinephile jurtina*) is well known as the sooty-winged Butterfly so abundant in all grassy places. The female is brighter than the male, her fore-wings being relieved by broad patches of dull orange, amid which the black eye-spot is more conspicuous. The downy, green caterpillar has a dark line along the back and a whitish stripe along each side. The Gatekeeper (*Epinephile tithonus*) looks much like a smaller and brighter female Meadow Brown, but the eye-spot usually bears two white "pupils." Here again the female is much brighter than the male. The caterpillar is pale yellow. The Ringlet (*Aphantopus hyperantus*) may be passed over as an extra dark male of the Meadow Brown, for it has no relieving patch of orange; but there are two or three obscure pale-ringed black dots on each of the wings, more numerous and plainer on the under side, especially in the female. The caterpillar is pale brown, with a darker line down the back. The Large Heath (*Cænonympha tiphon*) has a similar type of ornamentation, but the general colour is tawny, varying to a smoky shade. As in its congeners the under side is much more attractive than the upper. The caterpillar is bright green with three darker green lines along the back. The Small Heath (*Cænonympha pamphilus*), though only an inch and a quarter in the spread of the wings, is a very noticeable Insect in grasslands, the colour being pale tawny, often tinged with orange and having a thin dark border to the wings. There is a single small black spot near the tip of the fore-wing.

The next family, the Lycænidæ, includes

eighteen species of Hairstreaks, Coppers and Blues, of which several are exceedingly rare, and it is to be feared that one, the Large Copper, has become extinct in recent years. The Hairstreaks get their name from the fine lines of white on the under side of the wings. There are five British species, and they are sufficiently distinct to obviate the need for any minute description. The caterpillars are flat and broad, almost woodlouse-shaped.

The Brown Hairstreak (*Ruralis betulæ*) is dark smoky brown; the male with some ill-defined pale spots on the fore-wing, which in the female becomes a distinct orange band. There are small orange marks near the "tail" in both sexes. The caterpillar feeds on blackthorn. The under side is ochreous crossed by white lines. It does not occur north of Westmorland. The Purple Hairstreak (*Bithys quercus*) has blackish wings shot with purple-blue, the female with a broad bar of purple along the hand margin of the fore-wing. Under side grey with a black-centred orange spot on the hind-wing. The caterpillar feeds on oak. The Black Hairstreak (*Strymon pruni*) is not really black, but a very dark brown in the male, less dark in the female. The outer border of the hind-wings has a band of orange spots, and in the female this is repeated on the fore-wings. On the brown under side the white line is broken into elongated spots. The caterpillar feeds on blackthorn. Restricted to the southern half of England. The White-letter Hairstreak (*Chattendenia w-album*) is similar to the Black Hairstreak male above, but without the orange band. On the under side it is distinguished by the white lines on the hind-wing taking the form of a W with the upright strokes much elongated. It is found as far north as Yorkshire. The caterpillar feeds on wych-elm. The Green Hairstreak

(*Callophrys rubi*) is brown above, but beneath all the wings are a beautiful green, enabling the Insect to vanish by settling upon spring foliage and elevating its wings, when it melts into its surroundings. The caterpillar feeds on genista, broom, furze, bramble, etc.

We formerly had two British species of Copper Butterflies—the Large (*Chrysophanus dispar*) and the Small (*Rumicia phlæas*), but owing to the draining of the fens in East Anglia where its caterpillar fed upon the great water dock, the Large Copper became practically extinct by the middle of the nineteenth century. The Small Copper, however, is one of the most plentiful as it is one of the brightest of our smaller Butterflies. The name is well chosen, for the fore-wings are mainly of a coppery-orange colour liberally dotted with black, of which there is also a broad border. The hind-wings are black with a marginal band of copper. The flat green caterpillar feeds upon dock and sorrel. As there are several broods, the Butterfly may be seen from May to October. In the autumn it comes into gardens to visit the flowers of Michaelmas daisies in particular.

There are eleven British species of Blues, but only seven are at all plentiful or widely distributed. The other four are the Long-tailed (*Lampides bœticus*), the Short-tailed (*Everes argiades*), the Mazarine (*Nomiades semiargus*) and the Large Blue (*Lycæna arion*). Of these both of the tailed species have been found in this country only occasionally, and they are doubtful natives; the Mazarine has scarcely been seen for half a century, and the Large Blue appears to be restricted in the present day to the Cotswolds and North Cornwall. The Silver-studded Blue (*Plebeius ægon*) is purplish-blue in the male and purplish-brown in the female, on the

upper sides; beneath it is grey, black-spotted and margined with an orange band and a line of spots whose blue centres are metallic and glistening. The white-dotted red-brown caterpillar feeds upon furze and bird's-foot. Although widely distributed over Great Britain, it is a doubtful native of Ireland. The Brown Argus (*Aricia medon*), though similar in size and shape to the last, and closely resembling the female, has no blue about it. On the greyish-brown under side the black spots are reduced to minute dots, each with a broad ring of white surrounding it. There are no metallic spots. The caterpillar feeds on rock-rose and stork's-bill. In the Common Blue (*Polyommatus icarus*) the male is a violet-blue with a hair-line border of black fringed with white. The female is brown with some traces of blue near the base of the wings, and a border of orange and black spots. The green caterpillar feeds on bird's-foot trefoil and rest-harrow. The male Chalkhill Blue (*Agriades coridon*) is of an exquisite silver-blue that suggests moonbeams; on the hind-wing there is a row of white-fringed black spots, and on all the wings there are broad fringes of white barred with black. The female is sooty-brown. The yellowish-green caterpillar feeds on horseshoe vetch; and the Butterfly is abundant on chalk and limestone hills. The Adonis Blue (*Agriades thetis*) is a more distinctly bright blue in the male, with black-barred white fringe, but no spots on the upper side; the female is blackish-brown, suffused with blue, with a border of orange and black spots on the hind-wing. The black-dotted green caterpillar feeds on horseshoe vetch. The Butterfly is found on the chalk-hills of southern England. The Holly Blue (*Celastrina argiolus*) is in both sexes coloured a lilac-blue, but the female has the outer margin and tip of the fore-wings

heavily bordered with black. The yellow-green caterpillar feeds on the flower-buds of holly, dogwood, buckthorn and spindle. The small size of the Little Blue (*Cupido minimus*) distinguishes it. In both sexes the colour is a smoky-brown, almost black, but in the male a sprinkling of blue scales justifies its name. The pinkish-brown caterpillar feeds on the flowers and fruits of the kidney-vetch.

The Large Blue (*Lycæna arion*) is distinct from the other Blues by reason of its larger size, its rich deep blue (in both sexes), its black border, and the black spots on the fore-wings—which are larger in the female. The caterpillar feeds on the flowers of wild thyme which it closely approaches in tint. When it has grown only to a quarter of its full size, it forsakes the wild thyme and seeks the ground—usually the roof of an ant-hill. What happened to the caterpillar afterwards was long a mystery. It has now been set at rest by the observations of Dr Chapman and Messrs Frohawk and Rayward. Like many other “Blue” caterpillars this species is provided with glands on the hinder rings of its body from which, apparently at the will of the caterpillar, a sweet fluid is emitted. When the caterpillar leaves the plant and goes upon the ground, as though seeking a place for hibernation, it is accosted by an ant (*Myrmica*) who “milks” it, and later when the caterpillar hunches up the fore-part of its body the Ant seizes it in its jaws and carries it, as a cat carries her kitten, into the Ant-nest. Here it completes its growth by feeding upon Ant larvæ, and recompensing the Ants by yielding them liquid refreshment. The caterpillars of the Chalkhill and Adonis Blues are collected by Ants and placed on suitable food plants that are growing above their nests, so that they may have them handy for “milking.”

A small Butterfly known as the Duke of Burgundy Fritillary (*Hamearis lucina*) superficially resembles one of the Skippers, but a closer inspection—especially of the under side—shows close affinity to the Blues. The ground colour of the upper side is black, chequered with angular spots of tawny colour. The under side is tawny spotted with white and black. The brown caterpillar feeds on cowslip. It is found chiefly in the South of England; and is our only representative of the family *Lemoniidæ*.

Of the Skippers, constituting the family *Hesperiidæ*, we have eight members, all of rather dull coloration and, consequently, regarded by the general public as Moths, though the Butterflies by no means monopolise the bright colours. Most of the Skippers are fairly widely distributed species, but the Lulworth Skipper is restricted to Dorset and Devon, and the Chequered Skipper to the connected counties of Bucks, Northants and Lincoln. The Essex Skipper is confined mainly to parts of Essex and Kent adjacent to the Thames and the sea, and the principal haunts of the Silver-studded Skipper are on the chalk-hills, where the Dingy Skipper is likewise to be found. Most of them spin a sort of cocoon or draw the edges of leaves together for the protection of the chrysalis.

The Grizzled Skipper (*Hesperia malvæ*) has the ground colour of the wings a brownish black, over which are closely sprinkled a number of more or less angular spots of yellowish-white. The caterpillar is pale green with lines of greenish-brown; it feeds on strawberry, cinquefoil and raspberry, under a shelter of silken threads. The Dingy Skipper (*Nisoniades tages*) has smoky-brown wings bordered with minute whitish dots, and on the forewings are two bands formed of darker oval spots.

The yellow-green caterpillar feeds on bird's-foot trefoil. The Butterfly affects sunny hillsides, preferably of chalk or limestone. The Small Skipper (*Adopæa flava*) has yellow-brown wings veined with black. The Essex Skipper (*Adopæa lineola*) is very like it, and was formerly confused with it, the chief distinction being found in the thickened ends of the antennæ which are black beneath in the Essex Skipper and brown in the Small Skipper. The caterpillars of both species feed on grasses. The Lulworth Skipper (*Adopæa acteon*) is very similar to these, but less bright in colour, though this is in most examples made up by a crescent-shaped line of orange spots, most noticeable on the fore-wings of the female. The caterpillars of this and the remaining species all feed upon grasses. The Large Skipper has dark brown wings veined with black, and the central areas with angular spots of yellow-brown. The Silver-spotted Skipper (*Urbicola comma*) is very similar above, though the spots are yellower; but the silvery spots on the under side make identification easy. The Chequered Skipper (*Carterocephalus palæmon*) has the wings more completely covered with well defined yellow spots, and a distinct line of small ones bordering each wing.

MOTHS

ALTHOUGH, when the scaly-winged Insects (*Lepidoptera*) of the world are considered, it is not possible to make a sharp distinction between Butterflies and Moths, it is possible and has long been customary to do so with the British species. In this restricted company—there are only about two thousand British Moths—it is easy to find differences, such as the absence of the nipped in “waist” which most of our Butterflies exhibit, the knobbed antennæ and the habit of erecting the wings over the back, so that their upper sides are hidden. Though the Burnet-moths and a few others have their antennæ thickened towards the tip, they are never distinctly knobbed. Moths, when at rest, either close their fore-wings over the hind-wings, as in the Hawk-moths and Owlets, or spread them all horizontally as in the Geometers. The coloration of the wings has relation to these habits, for the portions exposed when at rest (in both Butterflies and Moths) is that which best harmonises with the surroundings. Most Moths fly by night or at twilight, but some are diurnal, and these, as a rule, are more brightly coloured than the nocturnal species. There is often a considerable sexual difference in the antennæ of Moths—those of the male being feathered, whilst those of the female are thread-like. The pupæ of Moths are usually smooth and cylindrical, tapering behind, as contrasted with the angular chrysalids of Butterflies, and concealed in the earth or in a silken cocoon.

From their large size and heavy bodies the Hawk-moths (*Sphingidæ*) are the most imposing group of British Insects. There are ten species that pass through all their stages on British soil, and about seven others are by courtesy included in our lists owing to their custom of paying us flying visits. Among the real natives, though rather a rare one, the Death's-head Hawk-moth (*Acherontia atropos*) is the one that has most attracted the attention of the public by reason of the black-spotted yellow patch upon the thorax giving the impression of a human skull. With the photograph before one there is little need of description of so striking an Insect, beyond saying that the dark parts are black, clouded with brown, and the light parts orange. The dark band down the centre of the back is blue-black. The outspread wings span four and a half inches or more. The huge yellow-green caterpillar is about five inches in length. It has seven diagonal violet stripes along each side, and at the tail end there is a rough "horn" which curves backward and then up. Its natural food appears to be jessamine, bittersweet and "tea tree" (*Lycium*), but since the introduction of the potato to Europe it has shown a distinct preference for it. When full grown it burrows several inches into the ground, fashions an earthen cell and changes to a dark red-brown chrysalis, from which the Moth emerges a few weeks later. As caterpillar, chrysalis and Moth it has the power of emitting a squeak, which is said to help the Moth in its favourite habit of burgling bee-hives and indulging in the honey stores, which is rendered easier by the Moth's proboscis being abnormally short.

Another fine Hawk-moth is the Privet (*Sphinx ligustri*), which is often plentiful locally in the

South of England, where the privet grows wild on chalk downs and sea cliffs. The handsome green caterpillar, striped with violet and white on the sides, feeds also on garden privet, and we have seen several hundred full-grown larvæ feeding on one garden hedge in Cornwall. It also feeds on ash, lilac and teasel at times; and turns brown before burrowing into the ground for pupation. The Moth is pinkish, clouded and banded with blackish-brown. A much more plentiful species is the Poplar Hawk-moth (*Amorpha populi*) with grey wings banded and streaked with brown, and on the inner margin of the hind-wings a big rusty "thumb-mark." The rough-skinned green caterpillar has the side stripes yellow, and it feeds on the poplars, willow, and other of the willow tribe. The very dark chrysalis lies only a little below the surface of the ground. By no means so plentiful, though certainly not rare, is the Eyed Hawk-moth (*Smerinthus ocellatus*), whose identification is made certain by the blue and black "eye" on the pink hind-wings. Its caterpillar may be found on willow, poplar, and apple trees. Also frequent in the South of England, where lime and elm trees are abundant, is the Lime Hawk-moth (*Mimas tilia*), with narrow pinkish-grey wings, spotted or barred and shaded with olive. In addition to lime and elm the wrinkled green caterpillar feeds on willow, birch, and alder. The Elephant Hawk-moth (*Chærocampa elpenor*) has the wings narrow, the longer fore-wings coloured a pale greenish-brown, lined and bordered with pink, the inner margin white; the hind-wings have the outer half pink, the remainder black. The greenish body is streaked and lined with pink. The dark brownish-grey caterpillar feeds on the large willow-herb ("codlins and cream") and water

bedstraw. On the sides of the third, fourth, and fifth rings there are black and white or black and yellow spots, which can be enlarged by the resting caterpillar drawing in its head. It has then a very formidable and threatening appearance which is believed to protect it from some enemies. The Small Elephant Hawk-moth (*Chærocampa porcellus*) is very similar, but only about half the size. The caterpillar has similar eye-spots, but may be known by the absence of the usual horn at the rear. It affects the same food-plants; also purple loosestrife.

Very different from the foregoing giants is the the Humming-bird Hawk-moth (*Macroglossa stellatarum*), that has frequently inspired newspaper reports that the humming-bird of the tropics has been paying a visit to the South of England, and has given rise to heated discussions as to whether the humming creature poised on scarcely perceptible wings before the flowers of jessamine is bird or insect. The Humming-bird Hawk-moth has the fore-wings dull brown crossed by thin bars of black, and the hind-wings orange thinly bordered with brown. It is believed that the Moths seen here in May are visitors from the Continent which lay their eggs on one of the bed-straws or the madder, where in summer we find the white-dotted green or brown caterpillars which become Moths in the autumn. Occasionally, these hibernate to continue the race next year; but usually it appears that the British-born examples leave no descendants.

Two other Hawk-moths are of similar form to the Humming-bird Hawk, though rather smaller, and after the first flight the greater part of the wing area is transparent and devoid of scales. These Insects are the Broad-bordered Bee Hawk-



HUMMING-BIRD HAWK-MOTH

Heteroglossa stellatarum,
feeding on Spur Valerian

moth (*Hemaris fuciformis*) and the Narrow-bordered Bee Hawk-moth (*Hemaris tityus*). Their names indicate the difference between them, but in addition the broad wing-border of the first is red-brown, whilst the much narrower borders of the second are nearly black. The same distinction of colour marks the broad band that crosses the body. The caterpillar of the first feeds upon honeysuckle, that of the second on devil's-bit scabious. Like the Humming-bird Hawk-moth, both these species fly in bright sunshine.

The family of the Prominents (Notodontidæ—toothed backs) gets the name from the presence in many species of tufts along the hinder edge of the fore-wings. When at rest the wings are closed over the back, and these tufts stand up in a manner suggesting the name. In most of the species the males have feather-like antennæ. They are night-flyers. The majority of the caterpillars are smooth, and some have extensible "tails" which appear to be used like the tails of cattle for disturbing the assaults of parasites. The chrysalids are usually protected by cocoons, often of very hard consistence, owing to the combination of wood particles with the silky material furnished by the caterpillar's spinnerets. Most noteworthy of this family is the Puss-moth (*Dicranura vinula*), whose thick fluffy body has suggested its name. It may be described in general terms as whitish-grey with many brown and black lines, mainly following the structural nervures. In both sexes the antennæ are feathery, more so in the male than in the female. The large flat-bottomed brown eggs are laid in twos or threes on the leaf of poplar or willow, and the newly hatched caterpillars look just like smuts from the chimney that have caught

on the leaf. When full grown, however, the mainly green caterpillar is as imposing as a Hawk-moth larva. The upper side is purple-brown bordered with white, and in the middle this dark coloration is extended down the sides constituting a saddle-like mark. At the end of the body, in lieu of the usual claspers, there are two horizontal tails which can be curved over the back, and long pink lashes protruded from them. Viewed from the front, when the caterpillar is annoyed, the appearance is grotesque, for the fore-parts are raised, the head drawn into the next ring, and a couple of dark spots simulate a pair of staring eyes. The cocoon is spun in a crevice of the bark, gnawed fragments of the same being incorporated with it to make a thick hard shell that corresponds in colour and texture with its surroundings. Three smaller species known as Alder Kitten (*Cerura bicuspis*), Poplar Kitten (*Cerura bifida*) and Sallow Kitten (*Cerura furcula*) have similar habits.

The Lobster-moth (*Stauropus fagi*) is another notable Prominent, somewhat resembling in its fluffiness the Puss, but of a brownish-grey colour with paler spots and zigzag line; but these markings are neither so strong nor so numerous as in the Puss. The name is said to apply to the remarkable form of the caterpillar, but after a long and very intimate acquaintance with the Crustacea we have never succeeded in persuading ourselves that there is the ghost of a resemblance between the caterpillar and its namesake. It is so extraordinary in its form that it is unlike any other living creature, the second and third pairs of legs being of remarkable length for any caterpillar, the back thrown up into a number of peaks, and the rear portion thrown over the back and inflated

when necessary to warn any aggressor. It feeds chiefly upon beech and oak.

The characteristic prominences on the hinder edge of the fore-wings that have earned a name for this family are strongly developed in the case of the Pale Prominent (*Pterostoma palpina*). The pale brown Moth when at rest rolls its wings around the body, so that it looks like a curled dead leaf and eludes observation. The white-lined, bluish-green caterpillar feeds on poplar, willow and willow.

A more familiar and striking member of the family is the Buff-tip Moth (*Phalera bucephala*) which has the same habit of rolling its purplish-grey wings around its body, when it resembles a short piece of fungus-rotted branch, the yellow patch at the wing-tips showing just that quality of wood. The rather large and conspicuous caterpillar is yellow with broken lines of black covered with soft hairs. This association of black and yellow constitutes a "warning" type of coloration, advertising to all whom it may concern that the caterpillar is inedible; and to give greater force to it, until nearly full grown the larvæ feed in companies. They are pretty general feeders, but are most likely to be seen on hazel bushes, where they are more on a level with the eye.

The family Thyatiridæ includes the Peach-blossom Moth (*Thyatira batis*) whose brown fore-wings bear large pink spots that suggest fallen petals of the peach. The red-brown caterpillar, whose back is thrown up into a number of ridges, may be found on bramble.

The Tussock-moths (Lymantridæ) include several species that may be met with commonly, one of them—the Vapourer (*Orgyia antiqua*)—

showing a strong liking for the squares and public gardens of central London, the brown-winged male with its single white spot on the fore-wing being a common object of the thoroughfares in late summer, whilst the wingless female may be found covering with eggs her smoke-grimed cocoon on the trunks of the plane-trees. The handsome caterpillar, with its spots and lines of black, red, and yellow, and its brushes and fringes of hairs, is protected from the London sparrow by its warning coloration and its stinging hairs, the latter causing much physical discomfort when the caterpillar drops inside the pedestrian's collar. The Yellow-tail (*Porthesia similis*) and the White Satin Moth (*Stilpnotia salicis*) are conspicuous from their habit of resting during the day on tree trunks and palings, when their white silky wings attract attention. The Yellow-tail, which is the smaller of the two, is distinguished by the extremity of the body covered with fluffy golden scales which are more abundant in the female, whilst the male has a black spot (occasionally two spots) near the hind margin of the fore-wing. A similar species is the Brown-tail (*Euproctis chrysorrhœa*) with the anal tuft of a browner tint. It is found almost exclusively on the coasts of Kent and Sussex. All of these have caterpillars decorated with brushes of hairs much like those of the Vapourer—with variations from it. The sexes of the Moths are distinguished by the feathery antennæ of the males.

Two larger species are the Gipsy (*Lymantria dispar*) and the Black Arches (*Lymantria monacha*), but the Gipsy though a serious pest in the United States, where it has been introduced, is all but extinct in this country. The grey-brown male is only half the size of the nearly white female.

The Black Arches is widely distributed. The white fore-wings have the characteristic zigzag lines in black, but on the smoky hind-wings the marginal pattern is not sharply defined. The stout body of the female is pale crimson, banded and spotted with black. Although similar coloration is found in the male, it is paler and weaker. The hairy caterpillar, blotched with black, lined with grey and dotted with red, feeds on oak and apple.

The Lackeys and Eggers constitute the family Lasiocampidæ, whose British representatives are all fairly large Moths of some tint of brown; the males with feathered antennæ. The caterpillars are hairy. The Lackey (*Malacosoma neustria*), which is one of the smaller species, has ochreous, pale brown or red-brown wings, with two dark cross-lines on the fore-wings. In the female the space separating these lines is usually of a darker tint. The female has a curious way of depositing her eggs in spiral rings around a twig. These hatch in spring, and the young caterpillars weave a silken web enclosing a number of twigs of their food plant. On this they are fond of basking during the sunny hours. The slaty-blue, hairy caterpillar is marked with parallel lines of white, black and red. It feeds on hawthorn, fruit, and other trees. The December Moth (*Pæcilocampa populi*) departs from the habits of most Moths in making its appearance late in the year, from October onward, but chiefly in November and December; in consequence it is most frequently seen around the public lamps, attracted by the light. It is a smoky-brown Moth with two pale lines across the fore-wings; the female much larger than the male. The Small Egger (*Eriogaster lanestris*) is a very similar Insect, but may be known by a whitish

spot about the middle of the fore-wing. The larger female has a thick rounded tuft of grey scales at the hinder extremity. It does not appear until February, and remains in evidence until March. The Oak Egger (*Lasiocampa quercus*) is the finest member of the family, the female measuring nearly three inches across the beautiful fulvous wings, which are crossed by a dark waved line, and near the centre of the fore-wing there is a dark-outlined whitish spot. The smaller male is much darker, mahogany-coloured, with a yellowish band crossing all the wings. The Moths fly during the daytime; and the exposure of a newly emerged female in a cage will bring all the males of the district around. The dark brown furry caterpillar is striped with white along the sides and spotted with red. When it coils into a close spiral on being alarmed, it shows intense black between the rings of its body. It feeds upon bramble, dogwood, hawthorn, and other bushes—not oak as its name might lead one to conclude. It is to the firm texture of the oval cocoon spun by this and allied caterpillars before pupation that the term Egger is due. A somewhat similar Moth is the Drinker (*Cosmotriche potatoria*), but its fore-wings are less rounded, more pointed at the tips, and the hind-wings are relatively smaller. In the female the wings are yellow with an oblique brown line running from the tip of the fore-wing to the centre of its hind margin, and a curving line crosses the broadest part of the hind-wing. There are two light spots above the centre of the fore-wing. The smaller male has the wings more or less suffused with brown. The large hairy caterpillar is a thirsty Insect, and may commonly be seen drinking at the globules of dew hanging on the grasses upon

which it feeds, and to which later it attaches its long slender cocoon.

The handsome Emperor Moth (*Saturnia pavonia*) is our only representative of the family Saturniidae, and may be known by its purple-grey wings being each decorated by a central eye-spot. The smaller male is of browner coloration than the female, and has the antennæ finely feathered. The bright green caterpillar is marked with black and studded with pink or yellow warts which bear tufts of black bristles. It feeds on a variety of plants, including heather, bramble, purple loosestrife, and meadow-sweet. It spins an ingeniously constructed double cocoon, so contrived that the narrow end affords an easy exit for the emerging Moth: the converging threads effectually closing it from without but separating on the slightest pressure from within. The male flies by day, but the female rests on the heather with the wings so arranged that the eye-spots on her fore-wings in conjunction with the head gives the appearance of some cat-like animal, which would suffice to scare off any Insect-eating bird.

The family Drepanidae includes the Hook-tips, so-called because the tips of the fore-wings have sharp, curved tips. They are all some shade of brown with darker lines and spots, and as they rest during the day among the foliage they resemble withered leaves. The caterpillars are more or less angled and humped, and have no claspers at the end of the body. They rest with the head and tail elevated like a Puss-moth caterpillar which some of them suggest on a small scale, as may be seen in the larva of the Oak Hook-tip caterpillar, which looks like a small curled-up leaf. One of the family known as the Chinese Character (*Cilix glaucata*) differs from

the other members in having silvery white wings blotched with brown and the tips rounded instead of hooked. It occurs along every hedgerow, but may be passed by easily as a bird-dropping as it rests with outspread wings on a leaf.

The Moths of the larger family Arctiidæ are known collectively as Tigers and Footmen, and a few are both large and brilliantly coloured. The caterpillars are more or less hairy, those of the Garden Tiger and the Ermines exceedingly so. They all feed upon low-growing plants, and some of the Footmen restrict their dietetic attentions to lichens. The well-named White Ermine (*Spilosoma menthastri*) has the hind-wings pure white and the fore-wings creamy dotted with black. The Buff Ermine (*Spilosoma lubricipeda*) is very similar, but the wings are more ochreous and the spots less scattered and forming a more or less definite line from the tip to the hind margin. The larva is the brown long-haired caterpillar so frequently seen, walking at great speed, in the garden, whose movements have earned for the species the name of *lubricipeda*—slippery footed. The Garden Tiger (*Arctia caia*) is one of the best-known of Insects to the non-entomological public, to whom, however, its gaudy colours suggest a Butterfly. The creamy fore-wings are heavily marked with brown, and the red hind-wings bear big black spots usually with blue centres. The body behind the brown thorax is also red with several bars of black. It is difficult to catch a couple of specimens that agree in their markings, whilst if we look through the collection of a breeder we shall find that the range of variation in artificially reared examples is endless. The caterpillar is black, abundantly clothed in very long brown and grey hairs, and familiar to

gardeners under the name of "woolly bear." The Scarlet Tiger (*Callimorpha dominula*) is so brilliantly coloured that it might pass for an immigrant from the tropics. The fore-wings of olive-brown with a green gloss are spotted with cream and orange, and the hind-wings crimson with black markings. It is, unfortunately, not a common species like the Garden Tiger, for though widely distributed, it is local. It has a preference for moist situations. The Cinnabar (*Hippocrita jacobææ*) again, which revels in this same contrast of crimson and black, is one of the most abundant of our Insects, and in some places in May may be seen in swarms flying lazily in the sunshine as though fully conscious that its warning coloration fully protects from attack. The fore-wings are entirely black save for a marginal bar and two spots of crimson, whilst the hind-wings are wholly crimson with the exception of a thin border of black. The caterpillar presents a similar contrast in colours, for it is ringed alternately with black and orange. Thus protected, it flaunts itself openly all day on the stems and leaves of its food-plant, the common ragwort.

What country folk commonly class under the name of "Owlets" from their being with few exceptions night-fliers, constitute the huge family Noctuidæ—shortened by collectors into Noctuids. Most of the caterpillars, too, feed only at night, hiding by day. They are mostly naked and smooth, but in the first few genera they are more or less hairy and like the Tussocks. The Moths as a rule are some shade of brown, at least on the fore-wings. In the present work it is only possible to describe a few common species illustrative of so large a family, taking advantage of its division into sub-families.

A small group of Owlets have the grey forewings ornamented with dark marks which resemble a dagger or a broad arrow according to the point of view. Two species, known as the Dark Dagger (*Acronycta tridens*) and the Grey Dagger (*Acronycta psi*), are so exactly alike that no one is clever enough to say which is which unless they have reared their specimens from the caterpillar stage, in which they are sufficiently distinct. The probability is that they are one species with two forms of caterpillars. The latter are both black, but whilst the Dark Dagger has the broad stripe along the back of a reddish tint, that of the Grey Dagger is yellow.

The Marbled Green (*Bryophila glandifera*) is one of the smaller Owlets, with green or greyish-white wings and darker grey markings which vary greatly in intensity. It is fond of sitting on old walls or rocks, particularly along the south coast of England. Its greenish caterpillar feeds upon the lichens that clothe these walls or rocks, but it is shyer than the perfect Insect, retiring during the day into silk-lined crannies. A very similar, but smaller, Moth, the Marbled Beauty (*Bryophila perla*) occurs further inland, and may be found on walls and tree trunks.

A large number of brown or dusky Owlets belonging to the genera *Agrotis* and *Noctua* are known as Darts and Rustics. Their markings are very indefinite, and identifying descriptions cannot be given in a few words. They feed in the caterpillar stage on low plants, and some of them, of which the Turnip Moth (*Agrotis segetum*) is a familiar example, do considerable damage in the kitchen garden.

The Yellow Underwings (*Triphæna*) as a group are very distinct by reason of the bold black-

bordered yellow or orange hind-wings, though the species may not be separated so easily in all cases. The fore-wings are brown, varying from purplish-brown to grey-brown, with darker marks. The caterpillars are brown, with oblique streaks or wedge-shaped marks on each side of the central line. The Large Yellow Underwing (*Triphæna pronuba*) is a familiar species to all who engage in gardening, and has a span of two inches and a quarter. It hides during the day under low plants, and on any interference with these runs out swiftly like a mouse; then if cover is not immediately available, it flies low and straight, to vanish in a more suitable spot near by. The black band on the yellow hind-wings does not reach nearly to the inner margin. The female lays a prodigious number of creamy white eggs with great economy of space, on grasses, flags, or on tennis-netting. They hatch in about three days. The caterpillars are pretty general feeders on low plants. When full fed it goes just under the surface of the earth, and changes to a stout red-brown chrysalis. The Lunar Yellow Underwing (*Triphæna orbona*) is a third less in size, the black band on the hind-wing extends to the inner margin and there is a black spot in the middle near the front margin. In these points it agrees with the Lesser Yellow Underwing (*Triphæna comes*) but *orbona* has a small dark triangular spot near the tip of the fore-wing which is lacking in *comes*. The Broad-bordered Yellow Underwing (*Triphæna fimbria*) is as large as *pronuba*, but its hind-wings are orange and the black border is twice the breadth of that of *pronuba*; moreover, it extends to the inner margin. The Lesser Broad-bordered Yellow Underwing (*Triphæna ianthina*), though much smaller, is similar, but the black border

extends up the inner margin which is also broadly clouded with black. The Least Yellow Underwing (*Triphæna interjecta*) is smaller still but marked like *pronuba*, except that the black border extends slightly up the dusky inner margin.

A small group of strongly built Moths known as Arches (*Aplecta*), and Brocades (*Mamestra*), though variable in tint, have a strong family likeness in the kidney-shaped spots and zigzag lines of the fore-wings. A good illustration is afforded by the Grey Arches (*Aplecta nebulosa*), a woodland species shown on Plate 5 in its characteristic daytime pose on the bark of an oak tree, where it needs the eye of a naturalist to detect it, so well does it harmonise with its surroundings—the lichen-spotted bark. Another familiar form is the blue-black Dot Moth (*Mamestra persicariæ*) with the white kidney-shaped mark, which is frequent in gardens with the similar but brown-coloured, Cabbage Moth (*Barathra brassicæ*).

A company of smaller but neat-looking Moths is represented by the local Marbled Coronet (*Dianthæcia conspersa*) which may be found in June resting on trunks. The caterpillars of all the genus have a special liking for the seeds of various plants of the campion tribe. Another species whose white and dark brown marbling fits in so well with lichen-spots is the Broad-barred White (*Hecatera serena*), found chiefly in southern England. The Figure of Eight Moth (*Diloba cæruleocephala*) has a rude representation of an 8 on the fore-wing adjoining the kidney mark that is so frequent in the Noctuæ. The black-dotted blue-backed caterpillar may be often seen in swarms covering a bush of hawthorn or blackthorn, soon stripping it of leaves.

Two Moths that may be encountered commonly on fences and tree trunks are the Clouded-bordered Brindle (*Xylophasia rurea*) with light brown wings irregularly marked with dark brown; and the related Light Arches (*Xylophasia lithoxylea*) with ochreous wings clouded and marked with brown. The caterpillars feed on grasses. The Angleshades (*Phlogophora meticulosa*) is familiar in every garden as well as in the open. The pinky-brown fore-wings are exquisitely shaded with darker tints, and in the centre is a triangular patch of olive green. At rest it resembles a shrivelled leaf. The white-dotted green or brown caterpillar is ornamented with a series of V-marks on each side of the pale central line. It does good in the garden by its attacks on groundsel, but as a set-off disfigures the bedding pelargoniums.

One of the largest of the Noctuid Moths is the Old Lady (*Mormo maura*) whose span of wings varies from two and a half to nearly three inches. It is streaked and clouded with various shades of brown, of which the darkest is almost black. The hind margins of all the wings are scalloped. When the Moth is at rest, with only the fore-wings showing, the origin of the popular name is explained: the appearance presented is that of the upper part of an elderly lady of mid-Victorian days whose shoulders are covered by a scalloped and fringed mantle of quiet tones! The Moth resembles several of our bats in seeking a daytime resting place in out-of-the-way corners of outhouses, coal-sheds and roofs, to which it will return morning after morning and sleep until evening. The caterpillar at first feeds on low weeds, but after hibernation turns its attention to bushes and trees. The reddish chrysalis is powdered with a bluish "bloom."

The Wainscot Moths (*Nonagria* and *Leucania*)

are pale brown with long narrow wings, found chiefly about fens and marshes, where the caterpillars feed in the stems of reed, reed-mace and similar plants. The Pine Beauty (*Panolis piniperda*) is frequent in pine woods in the spring, its white-spotted red-brown wings assimilating with the red trunks when it settles. The beautiful caterpillar is lined alternately with white and green which makes it all but invisible when feeding on the pine-needles.

In the early days of spring the watcher of palings and tree trunks in the southern half of England will be sure to meet with a fluffy fronted Moth of clean whitish-grey colour with brown markings, including a marginal line of small wedges on the fore-wings. This is the Early Grey (*Xylocampa areola*) which thus settles down after a night's enjoyment at the willow catkins. In similar situations in June will be seen the much larger Shark (*Cucullia umbratica*), a common representative of a small group distinguished by their long, narrow wings of a smoky-grey tint overlaid with blackish streaks. Some of the caterpillars are warningly coloured, as will be seen in the locally common Mullein-moth caterpillar (*Cucullia verbasci*) which is white ringed with yellow and spotted with black. As though conscious of its unpalatability it exposes itself openly on its food-plants, the mullein and figwort.

We have already mentioned the Yellow Underwing Moths in detail, and it is curious to meet with four quite unrelated species which reproduce on a very small scale the characteristic decoration of the former. One of these, the Beautiful Yellow Underwing (*Anarta myrtilli*) may be found flying in the sunshine over heath and heather, upon which its pretty green white-spotted caterpillar may be found

feeding; but so close is its imitation of a sprig of heather that a sharp eye is needed for its detection.

Our sole British representative of the sub-family Gonopterinae is known as the Herald Moth (*Scoliopteryx libatrix*). The reddish-grey fore-wings have the outer margin boldly scalloped, and the wing is crossed by a double, pale, curved line. The slender green caterpillar, which feeds on various species of willow and poplar, spins a slight cocoon in a curled-up leaf and changes to a black chrysalis which has a short ridge on its head.

The sub-family Quadrifinae includes ten species whose fore-wings are embellished with bright metallic marks, which shine brightly in the sunshine. Among these is the Golden Plusia (*Plusia moneta*) which was first noticed in this country about the year 1890, but has now got firmly established in gardens where monk's-hood and larkspur is grown. It is a brownish-grey Moth whose fore-wings are washed with gold. It appears to have reached us from the Continent. A more plentiful species is the Silver Y (*Plusia gamma*), found in every garden, whose purple-brown and grey fore-wings bear a central Y marked in silver. The home-bred supply appears to be considerably augmented by immigrants from across the Channel. Somewhat similar is the Beautiful Golden Y (*Plusia pulchrina*), but the wings have a more rosy tinge, and the metallic marks consist of a V and a dot in shining gold, the two sometimes connected to form a Y. Another common species is the Burnished Brass (*Plusia chrysitis*) in which the greater part of the fore-wing is metallic yellow, sometimes greenish tinged. A bright little Moth with wings spotted and blotched with yellow and dark brown is frequent in meadows in the early days of summer. It is the Mother Shipton (*Euclidia*

mi), so named because the fore-wing seen from the outer margin bears the nutcracker profile of the alleged prophethess.

The same sub-family boasts a few quite large and handsome Moths including the rare Clifden Nonpareil (*Catocala fraxini*) with grey fore-wings spanning three inches and a quarter and the smoky-brown hind-wings banded with violet. Nearly as large is the fairly plentiful Red Underwing (*Catocala nupta*) which often sits during the day on telegraph posts, to which after its evening flight it will return day after day. Its fore-wings are grey crossed by zigzag blackish lines, and the red hind-wings are deeply margined with black and almost crossed by an irregular black band. A similar species, with light-spotted, dark brown fore-wings and the red of the hind-wings a purplish-crimson, is known as the Dark Crimson Underwing (*Catocala sponsa*); but it is to be found chiefly in the New Forest.

The sub-family Hypeninae includes the Snout Moths, of which at least one, the Snout (*Hypena proboscidalis*) is a familiar summer Insect everywhere as it sits with its purplish-brown wings closely folded and its two palpi extended straight in front of the head, thus suggesting its name. The green caterpillar feeds on stinging-nettle.

The last sub-family of the Noctuidæ is represented by the Orange Underwing (*Brephos parthenias*), so conspicuous in spring around birch trees, on which as a white-lined green caterpillar it fed. The smoky fore-wings have bands and lines of black and a conspicuous whitish patch near the middle, whilst the deep orange hind-wings have a black margin and a large almost triangular dark patch occupying most of the inner half.

The Loopers (Geometridæ) constitute another

huge family, broken up into five sub-families. The names refer not to the perfect Insect, but to the caterpillar. The body of the latter is long and slender, and instead of the five pairs of claspers (of which four pairs are nearly central) previously met with, we find in *Geometer* larvæ only two pairs, situate at the hinder extremity. In consequence, when the caterpillar wishes to move forward, he takes hold with his true feet and brings his claspers close up behind them; the result being that the length of legless body in between forms a high and acute arch. Then the body is extended to its full length and the true legs take hold at a distance from the claspers. By this method, if necessary, a considerable distance can be traversed quickly. Many of the caterpillars, however, are very sluggish during the daytime, and will remain immovably extended at an angle from a twig, holding by their claspers alone. The object of this procedure is to escape notice, their colour agreeing with that of the twig upon which they stand and the deception being helped out by warts and humps that resemble buds. The Moths also differ greatly from the Noctuids, the body being slender and the wings are comparatively large and thin, more like those of a Butterfly. When at rest, although in many species the fore-wings are closed over the hind-wings to conceal them, in others they are spread out more like "set" cabinet specimens. As the coloration of the upper surface is usually of a protective character, it assimilates with the surface upon which the Moth is resting.

The scope of the present work only permits of a few representative examples of the principal sub-families being noticed.

The sub-family *Geometrinæ* consists of eight species of more or less beautifully coloured green

Moths, consequently known as Emeralds, one of them, the Large Emerald (*Geometra papilionaria*) being one of the largest of our Geometers, and about two inches across the wings. Its colour is a beautiful green, the wings fringed with white and crossed by two curved lines made up of white lunules. The Grass Emerald (*Pseudoterpna pruinata*) is a smaller species whose full beauty is to be seen only just after it has emerged from the chrysalis. Later its blue-green becomes suffused with grey.

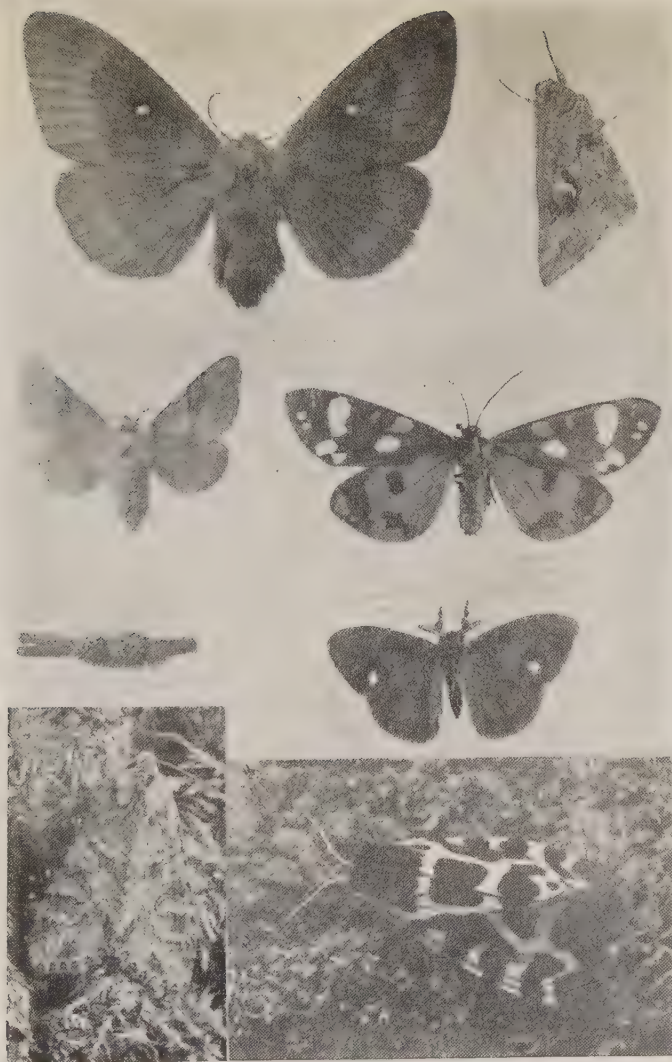
In the sub-family Acidaliinæ are included a number of rather small species known as Wave Moths, of which we may mention several. The Small Dusty Wave (*Acidalia virgularia*) is a brownish-white crossed by several fine waved lines made up of black dots. It may be seen frequently at rest on fences. The Fan-footed Wave (*Acidalia bisetata*) is whitish, bordered or banded with grey and a small black dot in the centre of each wing. The Cream Wave (*Acidalia remutaria*) has its whitish wings crossed by three or four dusky waved lines, but one or two of these may be very faint.

The Moths of the sub-family Hydriomenidæ are, as a rule, larger and with bolder markings. A familiar example is the Treble Bar (*Anaitis plagiata*), whose dove-grey fore-wings are crossed by three bars of purple-brown, each made of several curved and angled lines. The Winter Moth (*Cheimatobia brumata*), with unobtrusive grey-brown wings crossed by indistinct lines of darker tint, is one of the greatest pests the fruit grower has to contend with. It is for the all but wingless female of this species that the orchard owner girdles his trees with grease-bands and tar-bands to intercept them as they climb the trunks to lay their eggs among the leafless twigs. But in spite of

this barrier, which traps thousands, a sufficient number are carried up by the flying males to ensure a sufficient host of destroying caterpillars next spring. As indicated by the popular name, this Moth is only to be seen during the winter months—the males often swarming at night around the public lamps and the spider-like females on tree trunks. The Broken-barred Carpet (*Cidaria corylata*) as it sits on tree trunks through the day may be passed as a lichen-spot. The fore-wings are pale brown, barred and blotched with olive and lined with white. The Dark-barred Twin-spot (*Coremia unidentaria*) has whitish fore-wings crossed by a broad blackish band that has a prominent tooth-like projection on its outer side, just above which, near the margin, are two black dots. It may be seen at rest on palings frequently. The Flame Carpet (*Coremia designata*) has a similar scheme of decoration, but the broader part of the dark band has two projections and is edged with black. The Green Carpet (*Amœbe viridaria*), also of similar pattern, has the fore-wings (in freshly emerged examples) green, with the cross-band of a darker green, and where this touches the front edge there are two wedged-shaped black marks; the band is edged with white on either side, and there is a wedge-shaped black spot just below the tip of the wing. It rests during the day on tree trunks chiefly. The Silver Ground Carpet (*Xanthorhoë montanata*) observes the same general form of markings so far as the cross-bar is concerned, but this varies in strength and may be grey-brown or blackish-brown, and the ground colour varies from very pale brown to white. The very familiar Garden Carpet (*Xanthorhoë fluctuata*) has the cross-bar more or less curtailed behind, and the base and tip of the wing bear dark brown patches.

Several other "Carpets" may easily be confused with these in description, but the differences are pretty evident on comparing the Insects side by side. The Galium Carpet (*Xanthorhoë galiata*), for example, has a more definite border to the fore-wings which is continued along the margin of the hind-wings. In the Wood Carpet (*Xanthorhoë rivata*) the bordering on all the wings is stronger and broader, whilst the central bar of the fore-wings is continued in broken fashion on the hind-wing, as it is again in the Common Carpet (*Xanthorhoë sociata*). The May Highflyer (*Hydriomena impluviata*) has a greenish-grey patch at the base of the fore-wings, divided by a darker line and followed by a broad band of brown; then comes a band of greenish-grey succeeded by a wedge-shaped dark band made up of several tints of brown. It rests on tree trunks and fences.

The genus *Eupithecia* includes more than forty species of small neat Moths known as Pugs, in which various tints of brown are the prevailing colour. Many of them are much alike, and their identification often depends on minute details; moreover, they require very delicate handling. One of the most conspicuous of this group is the well-named Netted Pug (*Eupithecia venosata*), whose pale grey wings bear a bold pattern of black lines and curves which constitute an irregular network. It varies a good deal in the lightness or darkness of the ground colour. The caterpillar feeds in pods of bladder-campion. The Larch Pug (*Eupithecia lariciata*) is pale brownish-grey, with delicate darker markings. It will be found usually on the trunks of larch, upon whose foliage the slender, bright green caterpillar feeds. The Mottled Pug (*Eupithecia exigua*) is pale brownish-grey overlaid with blackish streaks and spots. It



To face page 64

MOTHS.

- 1 Oak-egger. 2 Silver-Y. 3 Lackey. 4 Scarlet Tiger.
- 5 Eggs of Lackey. 6 Vapourer. 7 Grey Arches. 8 Garden Tiger.



To face page 65.

MOTHS.

1 Red Underwing. 2 Shark. 3 Grey Dagger. 4 Pine Beauty. 5 White Plume. 6 Pale Oak-beauty. 7 Broken-barred Carpet. 8 Large Yellow Underwing. 9 Green Carpet. 10 Dotted Border. 11 Early Thorn. 12 Lunar Hornet Clearwing.

may be found reposing on trunks and fences; like all the Pugs it rests with its wings extended.

The sub-family Boarmiinae includes Moths of much larger size, and therefore more easily identifiable. Some of these, such as the Thorns and Beauties, have long slender caterpillars whose colouring accompanied by warts and other excrescences make them appear so twig-like as to deceive the birds that would otherwise destroy them. Several examples of these will be cited. In the Clouded Magpie (*Abraxas sylvata*) we find protection extended to both caterpillar and perfect stages, for whilst the white caterpillar is marked with contrasting lines of black and yellow, the Moth at rest on low plants looks like a large bird's dropping, the white wings being blotched with yellow brown. Far more familiar is the Currant or Magpie Moth (*Abraxas grossulariata*) by reason of its depredations on the bushes of currant and gooseberry in gardens. In this species there is a singular uniformity of warning coloration through the three later stages of existence, for the creamy white caterpillar is spotted with black and lined with red, the chrysalis in alternate bands of black and yellow is quite conspicuous through its flimsy hammock, and the creamy white ground colour of the Moth is overlaid with bold spots of black, mostly in lines, with two stripes of yellow between them. These colours vary greatly in their proportions, and the experiments of variety breeders have resulted in a most marvellous range of examples from forms with a mere sprinkling of small black spots to others in which almost the entire wing area is black. The Barred Red Moth (*Ellopija prosapiaria*) is the pale red-brown Moth seen frequently in summer in the pine-woods. The wings are crossed by two curved lines of a deeper tint edged with white. The

red-brown caterpillar, spotted with red along the back, is an example of protective resemblance, for it closely resembles a pine shoot that has been denuded of its leaves, even to the extent of showing points mimicking the bases from which leaves have been eaten. It feeds on the Scots Pine. As remarkable in this way are the caterpillars of the Thorn Moths. Of these a representative is shown at rest. This is the Early Thorn (*Selenia bilunaria*), so called because it appears in April. Its pale brown wings are freckled with darker brown, and there are three dark brown lines crossing the wing, as well as a dark crescent at the wing-tip. The under side is more prettily variegated, and as the Moth has the habit when at rest of elevating its wings butterfly fashion, it then closely resembles a dead and shrivelled leaf. The buff-coloured Scalloped Oak (*Crocallis elinguaris*) has the centre of the fore-wings crossed by a broad band enclosed by darker lines, and with a blackish spot in the broadest part. It may be seen sitting on trunks in summer.

The genus *Hybernia* is remarkable for the fact that the Moths appear in the most cheerless months of the year when, according to the townsman's belief, all nature is at rest. The grey-brown Early Moth (*Hybernia ruficapraris*) is about in January and February. The female has greatly abbreviated and quite useless wings. The variable, but usually more distinctly marked, Spring Usher (*Hybernia leucophæaria*) appears at the same season. There are several different forms with light brownish-grey ground, and the darker markings in various tints of brown. In another form the wings are almost uniformly blackish-brown with a few indefinite black marks. The female is a small, wingless, spider-like creature. The Dotted Border

(*Hybernia marginaria*) which appears, usually, in March, exhibits a similar variety. It may be almost without markings, of a smoky-brown thickly dotted with black, or be of a very pale brown with a darker marginal band and a row of tiny black dots close to the border. Here again the wings of the female are too small to be functional. The March Moth (*Anisopteryx æscularia*) is another variable Insect, the colour ranging from pale to dark brownish-grey, with a darker broken line as a border and a row of short dark dashes crossing the wing. The female is wingless.

The Pale Brindled Beauty (*Phigalia pedaria*) has brown-grey wings, rather indefinitely marked with short streaks of darker brown. There are four more definitely dark patches on the front margin of the fore-wings, and one or two curved dark lines on the hind-wings. The entirely wingless female has her long, pale yellow body dotted with black. The Brindled Beauty (*Lycia hirtaria*) has a stouter body and narrower wings, which are brown-grey, appearing to be dusted with black, and crossed in the male by several curved black lines. The female is fully winged like the male, but her wings are semi-transparent and the markings are not so distinct; moreover, she has thread-like antennæ, whilst those of the male are feathered. This is another early Insect, making its appearance in March. The blackish-brown, stick-like caterpillars feed on lime, elm and other trees, and are quite common in the London parks and gardens. The Peppered Moth (*Pachys betularia*), is so called because its large white wings look as though they had been peppered with black. On some parts of the wing the black occurs in larger spots, but these vary greatly and no definite pattern can be described. The caterpillar varies in colour from

greenish-buff to purplish-brown, much wrinkled and bark-like. It feeds on the foliage of various trees; also on rose and bramble.

The Waved Umber (*Hemerophila abruptaria*) is a much smaller Moth with pale brown wings marked with bars and oblique lines of dark brown. The effect is pretty, and when the Moth rests, as it is fond of resting, on oak palings, its decoration melts as it were into the natural graining of the wood. The Willow Beauty (*Boarmia gemmaria*) has the ground colour of the wings pale brownish-grey, over which is laid a more or less distinct but indefinite pattern of curved lines and crescents in dark brown and black. The twig-like red-brown caterpillar is a general feeder on shrubs and trees, and may be found commonly in gardens on ivy. The somewhat similar Pale Oak Beauty (*Boarmia consortaria*) has the ground colour greyer, dusted with black, and the overlaid pattern yellow-brown, but a scalloped marginal band is black. Although rather a local Insect, it is not rare in the South of England, and may be found sitting on trees and fences. The Engrailed (*Tephrosia bistortata*) and its earlier spring form known as the Small Engrailed (*Tephrosia crepuscularia*) are of the same type, and a better idea of their differences is to be obtained from a comparison of specimens than from a description. The allied Grey Birch (*Tephrosia punctularia*) has very pale grey wings with darker dusting, and three imperfect curved lines of blackish dots, but often it is difficult to trace these as lines.

Our last example of the Geometers must be the pretty little Common Heath (*Ematurga atomaria*) which abounds wherever heath and heather (on which the caterpillar feeds) grow. The ground colour is some tint of yellow, sometimes almost

white, upon which are laid curved, narrow bands of dark brown, some of them much broken.

The family Zygaenidæ includes the two small groups known as Burnets and Foresters. They have long narrow bronzed wings on which (in the Burnets) crimson is strongly contrasted with very dark green or black. The antennæ are thickened at the free end, reminding one of those of the Skippers among the Butterflies. They fly only in sunshine, and are found in company. The most familiar species is the Six-spot Burnet (*Zygaena filipendulæ*) which may be found in profusion on chalk-hills and along sea-cliffs. The flight is heavy, and the Moths are fond of sitting on flower-heads such as those of the field scabious and thistle. The fore-wings are blackish-green, with normally six crimson spots, but these are liable to merge into three or four. The hind-wings are crimson with a narrow border of dark green. The short, stout, greenish caterpillar is spotted with black and yellow, and feeds on bird's-foot, clover and allied plants in autumn, then hibernates and completes its growth in spring or summer, climbing the flowering stems of grasses and spinning a glazed, papery, yellow cocoon in which it changes to a black chrysalis. Both as caterpillar and Moth it exposes itself fully, as though conscious of the protection afforded by its warning coloration, whilst as a chrysalis it is protected by the resemblance of the cocoon to the flower clusters of the grasses around. The little Forester (*Ino statice*) has its fore-wings a dull golden green, without any markings, and the hind-wings smoky-brown.

From these small but brilliant Moths we turn to a large and dull coloured example of the family Cossidæ, in the Goat Moth (*Cossus ligniperda*), which measures three and a half inches across the

outspread wings in the larger female. The wings are mottled with various tints of brown as a ground colour, and on this there is a liberal streaking of darker brown and black. The Goat Moth is without a proboscis. The huge caterpillar, which gives off the strong goaty aroma that has earned a name for the species, has pinkish-yellow sides and a dark red back. It spends three or four years in tunnelling into the solid wood of elm, ash, poplar, willow and other trees, and when full grown leaves the tree to search for some suitable rubbish in which to construct a flimsy cocoon for pupation. The Wood Leopard (*Zeuzera pyrina*), a smaller Moth with white wings heavily spotted with black, has similar habits in the caterpillar stage, which is somewhat less protracted than in the Goat Moth.

The family Sesiidæ consists of beautiful Moths known as Clearwings, whose diurnal habits and the transparency of their wings cause them to be regarded by the general public as Bees, Wasps and Flies. Scales are developed as a covering for the wings as in other Moths, but are got rid of in emerging from the pupal skin or in their first flight. In the caterpillar stage they bore into the wood of trees and shrubs, one of them—the Currant Clearwing (*Sesia tipuliformis*)—making itself a nuisance in gardens by hollowing the stems of red and black currant bushes. They have been given fancy names which imply resemblance to specific Insects, but these are seldom justified. One of the largest, for example, is styled the Lunar Hornet Moth (*Trochilium crabroniformis*), but its light yellow colour has no resemblance to the brownish hornet, though it does mimic a wasp very closely.

The family Hepialidæ consists of the Ghost Moth (*Hepialus humuli*) and four species of Swift-moths. The Ghost Moth gets its name from the appearance

of the silvery-white male as he hovers at twilight, as though suspended from an invisible thread, over grass-lands. The wings are in such rapid vibration that their movements are not seen, and he hovers with a slight swaying motion that adds to the illusion of his suspension. At the same time he gives out an aroma which spreads widely and soon brings the larger, orange-spotted, yellow-winged female on the spot. The under side of the wings in both sexes is dark brown. The yellowish-white caterpillar lives underground, feeding upon various succulent roots, and is believed to spend two years in this stage.

CADDIS-FLIES

THE sombre-tinted hairy-winged Insects known as Caddis-flies constitute the order Trichoptera; but although there are about one hundred and fifty British species, they are chiefly known "in the lump" rather than as separate forms. They are too much alike for the general public to discriminate one from another, so they have never received English species' names. The fly-fisher, perhaps, can distinguish a few kinds which he may use for disguising his hooks, but his system of nomenclature is scarcely precise enough for an entomologist to follow. The average boy, who nearly always has an experience of collecting pond life—"tiddlers," newts, tadpoles, and beetles—knows the larvæ at least, putting them into his jam jar on account of the quaint portable houses or "caddis cases" that they build for the protection of their soft bodies.

In many instances some of the perfect Insects are mistaken for Moths, especially some of the smaller kinds, and formerly were classified as such by entomological authorities. But there are two ways in which the true nature of any doubtful example may be determined. First with the pocket-lens. In the case of the Butterflies and Moths (Lepidoptera) it has been shown already that the patterns on the wings are formed by minute scales; in the Trichoptera all such patterns are due to hairs of different colours. The second test is an examination of the mouth

parts. With a few exceptions among the Moths (whose real nature is shown by other characters) the mouth is transformed into a long proboscis for sucking purposes. In the whole of the Trichoptera there is no proboscis, but the mouth parts are intermediate in character between those of biting and sucking Insects; and it is believed that they partake of minute particles of solid food as well as of food in a fluid form.

There are four well-marked stages as in the Lepidoptera—egg, larva, pupa, and imago or winged stage. The eggs are not laid separately, but united by a jelly-like substance are dropped as a mass into the water, where the jelly by absorption largely increases its bulk and so separates the hundreds of eggs it encloses. The cylindrical mass may be attached to an aquatic plant; and it has been stated that the females of certain species actually descend into the water for the purpose of so attaching it.

The larva or "Caddis-worm" is soft-bodied, except the head and part of the fore-body (thorax) which as well as the long legs are horny, as these parts have no other protection when the Caddis-worm is moving about. Some of the rings of the hind-body bear tubular filaments in which are air tubes (tracheæ) which extract air from the water. The newly hatched larva immediately sets to work to construct a tubular garment to protect its soft body. Different species vary in their choice of materials for this purpose, some taking grains of sand, others small shells, particles of gravel, bits of leaf or cut lengths of grass. There are spinnerets among the mouth parts, connected with silk-glands, and the larvæ attach their materials by means of silk filaments. Some species that use heavy material counterbalance the weight by

attaching bits of twig. Every species—or at least every genus—has its own taste in the matter of materials and the method of arranging them; so that an experienced student of these Insects can identify the larva by means of its case. The larval period extends over several months, and in some species for nearly a year. As the larva increases in size the case is enlarged by additions to the front end; and when the time comes for pupation the case is moored to a plant or stone and silken gratings are spun across the ends to keep out intruders whilst admitting currents of water for the breathing of the chrysalis. The food of the Caddis-worms is chiefly water plants, but some are partially or entirely carnivorous, eating water-snails out of their shells and killing small tadpoles and other aquatic animals.

The pupa, or nymph, as it is more correct to speak of it, is much like the perfect Caddis-fly, with the legs and wings free though the latter are unexpanded. The change takes place within the skin of the larva which afterwards breaks away in pieces. To permit of the nymph's escape from the caddis case when the time for its emergence arrives, it is provided with a pair of powerful jaws with which it cuts through the impediments to its escape, swims back downwards through the water until it reaches a plant or bank, up which it climbs to the air. It there casts off the nymph skin and appears as a complete Caddis-fly.

The Caddis-fly has four wings, of which the hinder pair is the larger by reason of greater depth from back to front. When at rest the hind-wings are folded fan-wise. It does not appear to have great muscular control over these organs, for its flight is a feeble flutter, indulged in chiefly at night, and, as a rule, not far from the water.

During the day it may be found sitting on trees and fences near streams and ponds, but is never very conspicuous, some tint of brown or black being the prevailing colour.

Identification of species is very difficult unless one has opportunity for comparison with a collection made by a specialist; but as a preliminary specimens may be allocated to the several families into which the order is divided. These are only seven in number, and they are set out below with the chief characters of each.

Phryganeidæ. Wings short, broad, and downy, mostly with white or pale spots. The antennæ are as long or almost as long as the wings. The larvæ are found only in still waters. They make cases of equal thickness at both ends, and construct them of leaves or fibres arranged in a spiral. There are only a few British species, arranged in the genera *Neuronia*, *Phryganea*, and *Agrypnia*.

Limnophilidæ. Antennæ of similar length to wings, with basal joint enlarged. Larvæ in still or rapid waters. Materials of case variable, but some species use living water-snails for the purpose. One small species (*Enoicyla pusilla*) differs from all the others in living as a larva among moss and dead leaves, far from water, and the female "fly" has wings so minute that they are useless.

Sericostomidæ. Wings long-oval, densely downy; the nervures indistinct. The larvæ are almost always found in running streams, and form a case of sand or small stones. *Crunæcia irrorata*, which may be found in damp herbage about rock-springs, builds a four-sided case of small stones.

Leptoceridæ. Antennæ exceedingly long and slender. The larvæ build cylinders of sand. The nymphs of *Leptocerus aterrimus*, a common

species, may be found in groups of about twenty, clustering in overlapping rows around a submerged grass stem.

Hydropsychidæ. The larvæ construct flattish oval cases of stones which are fixed to larger stones at the bottom of streams. They are largely carnivorous, feeding upon other aquatic Insects. The males may be seen in bright sunshine, flying in crowds above the water. *Polycentropus flavo-maculatus* does not construct a case until it is ready for pupation, previously sheltering under stones. *Holocentropus picicornis*, a common species, has the habit as a winged Insect of running on the surface of the water.

Rhyacophilidæ. A small family whose larvæ inhabit torrents and clear swift streams, forming fixed cases on stones, similar to those of the previous family, but before changing to nymphs they construct movable cases and spin a thin brown cocoon inside.

Hydroptilidæ. Small Insects about a third of an inch across the outspread wings, with a close resemblance to some of the smallest Moths. The larvæ, which are without the respiratory filaments, make seed-like cases of silk, to which sometimes are attached grains of sand and diatoms. They will be found among water plants or on stones.

It is a good plan to collect the "caddis cases" and keep the various forms separately in glasses of water until the perfect Insects emerge. The association of the "fly" with its case is helpful in identification, as well as in elucidating the life history of the species.

MAYFLIES

FORMERLY included in the order Neuroptera with Dragon-flies, Lacewings and many other Insects that have transparent netted wings, the Mayflies for good and sufficient reasons are now separated to constitute the order Plectoptera, which is represented in Britain by about forty species. They are four-winged Insects, with large head and short antennæ, and the hind-body terminated by long, jointed tails (cercopods), of which there are either two or three.

Even many who have never seen a Mayfly know something about them from references in literature. In a way the swarming of the Mayfly has become as famous as the swarming of the locust, and whoever has indulged in even a moderate amount of what is called general reading has surely read graphic accounts of both. In the case of the Mayfly it may have been from the naturalist's point of view or from the angler's. To the latter the Mayfly of sorts is the "green drake," the "grey drake," or the "bastard drake"; but the naturalist who pays attention to these Insects finds that under the angler's name several species are often included—species that differ not only when he has got their dried, fragile bodies ranged side by side in his cabinet drawer, but also in their preliminary stages before the wings are donned and whilst the Insect is an inhabitant of the waters. In this stage the angler regards it as an entirely different creature, and knows it as "bank bait" because the larvæ of the common species dig themselves C-shaped burrows in the bank of the stream, below the surface of the water.

The two pairs of glassy, iridescent wings possessed by the Mayfly are disproportionate in size, the front pair having an area about three times as great as the hind pair. They are all transparent and have very numerous, slightly curved, longitudinal nervures connected by many cross nerves. The head is remarkable for the fact that there is no mouth, so that the perfect Insect is incapable of feeding. In some species, it is thought that vestiges of jaws and other parts have been detected, but even so they serve no purpose other than to indicate that remote ancestors had a mouth, just as present-day Mayflies have a stomach and intestinal tract. The hind-body is composed of ten visible rings, and to the last of these the long "tails" are attached. The eggs in a mass are dropped into the water by the female immediately after fertilisation, or are laid in batches on the leaves of aquatic plants, according to the length of winged life of the particular species.

When the young larva emerges from the egg some months later, it is long, slender and rather shrimp-like, with tails that are longer than the combined head and body. It breathes through its skin; but after its third moult it is furnished with gills along the back or the sides of the hind-body, and internal air-tubes in connection with these are developed. The very long tail processes also serve as breathing organs, blood being driven into them and so brought into contact with the oxygen dissolved in the water and absorbed by the skin. It feeds on the broken-up vegetable matter and minute animals found on the bottom of the stream, and remains in this aquatic stage for about two years, by which time the wing-pads have made their appearance and the larva has become an active nymph. At what one might assume to be its final

moult, the nymph comes to the surface, being buoyed up by gas accumulated in the alimentary canal and between the old and new skins. It splits its skin and walks out as the fully winged Mayfly. It takes a short flight to some convenient tree, paling or even a window, and fixing its feet takes a short rest. You may be watching that Mayfly at intervals for several days, and wondering when it is going to move. At length you discover that it is only a lifeless film—a sort of Mayfly ghost, a form without substance. The creature that alighted was not the perfect Mayfly, but what naturalists term a sub-imago. Soon after settling there its skin split and the Mayfly in its ultimate condition emerged.

To those acquainted with what takes place in the other orders of Insect life, this final moult is puzzling, as it appears to be so unnecessary that, when an Insect has acquired the winged state, it should almost immediately cast its skin. We have known young naturalists to be almost alarmed by the uncanny experience of finding apparently two Insects in the box in which they had certainly imprisoned only a single Mayfly on a streamside ramble. The second, it is true, is only a cast skin, but its attitude is so life-like, and the delicate tissue appears so intact that it is not surprising that it should be taken for a living thing.

When this last covering film has been cast off, the Mayflies rise into the air and form those swarms to which allusion has been made. It is a marriage flight analogous to that of the Ants before the females voluntarily cast off their wings. It has been described repeatedly, but more often it is the graphic account of Reaumur, the French naturalist, written nearly two hundred years ago, that is quoted. The "rise of the fly," as anglers term it,

takes place on about three consecutive evenings, and at this period a common impulse seems to seize the nymphs to cast off their skins and ascend into the air above the stream in myriads. Reaumur observed them over the Marne, and observes that "the myriads of ephemeræ which filled the air over the current of the river and over the bank on which I stood are neither to be expressed nor conceived. When the snow falls with the largest flakes, and with least interval between them, the air is not so full of them as that which surrounded me was full of ephemeræ. Scarcely had I remained in one place a few minutes, than the step on which I stood was quite concealed with a layer of them, from two to four inches in depth. . . . Eyes, mouth and nostrils were filled with them." His account appears to relate to *Polymitarcys virgo*, which does not occur in Britain.

Eaton, who is the chief authority on the Mayflies, says they fly both in the morning and the evening, up till a little after sunset. Their flight is peculiar, and characteristic of their kind, being almost vertically up and down—"a fluttering swift ascent, and then a passive, leisurely fall, many times repeated. The body during the rise is carried in a position very little out of the perpendicular, with the legs extended upwards in advance, and the setæ (tails) trailed behind."

The sexes pair during this flight, and whilst still on the wing the female drops her eggs—which are attached in a disc-shaped mass—into the water. This combination of the eggs appears to be a precaution to ensure their sinking to the bottom, for individually they are not heavy enough to penetrate the surface film, and they would be carried away and probably drift ashore in surface currents. In the water the connecting cement dissolves and the



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CADDIS-FLIES AND MAYFLY.

- 1 Small Caddis-fly. 2 Mayfly. 3 Large Caddis-fly.
4 Spawn of Caddis. 5-14 Cases built by various species
of "Caddis-worms."



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DRAGON-FLIES.

1 Nymph. 2 Nymph with mask open. 3 Demoiselle resting. 4 Nymph head and mask enlarged. 5 Agrion puella.

eggs separate. Then a zone of threads near the ends of each egg gets entangled in the debris of the bottom and they are anchored. There are from eight to twelve of these threads in each zone, and every thread has a knobbed end to help it in catching hold.

The brevity of the Mayfly's life is so short that it has passed into a proverb. It is not strictly true that it is necessarily bounded by a day, though it may be compressed into a few hours. It has been kept alive experimentally for several weeks; but this was probably an unpaired female. The absence of a mouth shows that the acquisition of wings is solely for the purpose of pairing; and that important function achieved and the eggs laid the Mayflies die. The stomach, useless for digesting the food that cannot reach it, serves to this end by being much inflated with gas and rendering the creature more buoyant.

Owing to the near resemblance of all the Insects in this order, the several genera are all included in a single family—Ephemeridæ. The principal genera are *Ephemera*, *Cænis*, *Cloëon*, and *Baëtis*; but the British Mayflies are distributed among thirteen genera.

The two common examples of the first genus are *Ephemera vulgata* and *Ephemera danica*. The larvæ are cylindrical with three tails, and the legs are robust and fitted for digging into the banks; the large gills are fringed. Those of *E. vulgata* frequent the quieter waters of rivers, whilst those of *E. danica* prefer the more rapid and cooler streams.

The genus *Cloëon* is distinguished when mature by the entire absence of the hinder pair of wings and the reduction of its tails to two. A remarkable feature of the male is the division of each compound eye into two masses, of which one part is mounted

upon an almost upright pillar and the other remains in the usual situation at the side of the head : so that in effect the Insect has four compound eyes, in addition to the three simple eyes that occupy the front of the head. The larvæ are of much more delicate structure than those of *Ephemera*, more adapted for their pursuit of swimming : they do not burrow, and their gill-plates are not fringed. The common species are *Chloëon dipterum* and *Chloëon dimidiatum*.

The larvæ of the genus *Baëtis* live in rapid streams, where they may be found clinging closely to rocks and stones, though they can run rapidly on occasion. They are exclusively carnivorous.

Other common species are *Habrophlebia fusca*, *Ephemerella ignita*, *Rhithrogena semicolorata*, and *Ecdyurus venosus*. But the rarer species may be abundant in certain favoured localities. They are to be sought in most cases near running water ; but a few prefer still waters. *Chloëon dipterum*, for example, lives as a nymph in clear ponds that from their situation have the water distinctly warm in summer ; whilst *Siphylurus lacustris* may be sought in the cool waters of Llyn Llydaw on the Snowdon slopes, one thousand four hundred and sixteen feet above the sea. Hedges and shrubs near the waters will be found good collecting places for the sub-imagines, resting before their final moult. If this has not taken place at the time of capture the Insects should be taken home in small wide-mouthed bottles, and kept cool till the perfect Insect has emerged. *Baëtis* will be found clinging to the aquatic vegetation only a few inches above the water. The sub-imago may be known from the perfect Mayfly by its duller general appearance, by the wings being fringed and the tails shorter than in the final phase.

DRAGON-FLIES

AMONG the most prolific hunting grounds for the general entomologist are old established ponds and their surroundings, or a stretch of one of the dis-used canals that are too common in the South of England. Here, owing to the absence of the tow-rope, the waterside vegetation has been able to establish itself vigorously along the banks, and in the undisturbed waters numerous aquatic plants flourish. The surface is broken by bold clumps of arrow-head and water-plantain, and in places is covered by the broad floating leaves of our two water-lilies, yellow and white. On the nearer margin there is a foamy ridge of fragrant meadow-sweet, sprinkled with forget-me-not, skull-cap and purple loosestrife, gipsywort and marsh woundwort; whilst on the opposite shore, beyond the low masses of lovely buckbean, rise the huge water-dock and the slender flowering-rush.

The underwaters have their jungles of water-weeds, and these shelter a host of Insects, some in their adult condition like the water-beetles and water-bugs, others as larvæ and nymphs, such as those of the Caddis-flies and Dragon-flies. In their ultimate, winged condition these Insects are abundant in the air, flying swiftly over the water or resting on the vegetation. Many are engaged in courtship, but the Dragon-flies are busy mainly in the pursuit of prey—other winged Insects which they chase and run down by their superior wing-power. The edge of a big cloud obscures the sun,

and at once all the Dragon-flies repair to the herbage or the foliage of alders and willows and become quiescent, the smaller kinds folding their wings to their sides and the larger elevating them over their backs or keeping them extended in the flying position. The legs are all directed forwards, and though they are used for clinging to the vegetation, you will never see a Dragon-fly walking on them. They are used chiefly for the capture of prey, and that appears to be the reason why they are all directed forwards so that the feet come just under the mouth.

These Dragon-flies fall obviously into two types of structure—big, stout-bodied creatures with stiff, powerful wings like the planes of an aeroplane, and small, slender-bodied, with thin, delicate wings. The big ones—the erroneously named “horse-stingers” of rural nomenclature—can be heard as their rigid planes cut the air swiftly; but the smaller sorts are too delicately built to cause any appreciable sound, and appear rather to be wafted on the air than to be impelled by vital mechanism. Yet, if we attempt to catch these feeble ones, we are astonished by the rapidity with which they elude us.

All these brilliant, flashing creatures of the air spend the earlier and greater part of their lives under water in the pools and streams. We may see the beginnings of this sub-aquatic existence by watching that female who sits on the floating leaf of *Potamogeton*, dropping her eggs into the water. Some species curve the body under the leaf and attach their eggs to the under-surface; others again fly close to the water and drop them as they go—thus scattering them over a wider area.

The creatures that emerge from these eggs have little resemblance to the parent, and those of the larger type of Dragon-fly—*Libellulidæ*—produce



FLAT-BODIED DRAGON-FLY

(*Libellula depressa*)

female resting on Iris leaves

By kind permission of Mrs W. Smith-Grant

larvæ that are not greatly like those of the smaller type—*Agrionidæ*. They may have broad bodies or slender ones; but they all have large eyes, six long, jointed legs, and the hind part of the body ending in triangular or oval flaps, which in the larger sort close together in a sharp point, and stop the entrance to internal breathing organs which absorb oxygen dissolved in the water. In the more attenuated larvæ this office is believed to be performed partly by the leaf-like processes themselves.

Ordinarily, these Dragon larvæ crawl slowly over the bottom, hunting for other Insects, larval newts or the fry of fishes, upon which they feed; but on occasion the stout-bodied ones can transport themselves more swiftly to a little distance by opening the tail valves and ejecting the water contained in the breathing chamber by muscular contraction. The force with which this gushes out sends the Insect forwards.

The head of the larva is provided with large compound eyes, as in the adult, and powerful jaws for the breaking up of its food. There is also a modification of the mouth-parts not seen in the adult or in any other group of Insects. This consists of a remarkable development of the lower jaw (maxilla) until it is half the length of the body. Looking the creature full in the face, however, you note nothing abnormal. This is due to the fact that the elongated jaw is hinged at its base and folded near the middle, so that it packs away under the head, and the pair of sharp nippers which ornaments the free end then fits close to the face and seems a part of it. In consequence it is known as the mask. In its use it is a deadly instrument.

Creeping up very slowly, the Dragon comes within short distance of its prey, yet not so close as to cause alarm. In an instant the mask is shot forwards on

its hinges, the nippers seize the victim and bring it back against the mouth of the Dragon, where the cutting organs demolish it. By such practices oft repeated the Dragon waxes large and powerful, casting its skin at intervals as growth necessitates. At the third or fourth moult a sort of hump appears on the Dragon's back, the addition consisting of the buds, so to speak, of its future wings. The larva has become a nymph, a stage corresponding to that of the chrysalis of a Butterfly or Moth. But unlike the larva of Butterfly, Moth, Beetle or Bee, when it reaches this stage the Dragon does not become inactive with all its organs sealed up. In the others there has to be an entire change in the structure of the mouth-parts as well as the development of wings, and the cessation of feeding and activity for a period is necessary to that end. In the case of the Dragon the familiar human notice, "Business as usual during structural alterations," would apply. The alterations do not seriously concern the mouth-parts, for as larva, nymph and winged Insect its food is of similar nature.

The absence of a resting pupal stage is not peculiar to the Dragon-flies, but will be found also in the Grasshopper family (*Orthoptera*), the Bugs (*Hemiptera*), Mayflies (*Plecoptera*), and the wingless orders. In such the metamorphosis is said to be incomplete; it would be more accurate, perhaps, to describe it as more gradual. Where the larva and the imago (adult) partake of similar food and there is, consequently, no radical alteration of the mouth, there is no need for a cessation of activities and no abrupt metamorphosis. In Insects like the Butterfly and its caterpillar, whose food is so different, there has to be a complete revolution in the mouth-parts, which, if activity were continued, would result in starvation; so that a completely



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DRAGON-FLIES.

1 *Aeschna cyanea*. 2 *Brachytron pratense*.



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DRAGON-FLIES.

- 1 *Libellula depressa*; 2 *L. quadrimaculata*. 3 *Orthetrum cœrulescens*.

inactive stage has to intervene whilst this reconstruction is being effected.

When the Dragon-nymph has attained to its maximum growth and the cramped-up wings in the pads are demanding room for expansion, the nymph crawls up some aquatic plant until it is well out of the water. Then it takes firm hold with the curved hooks that terminate each limb, and rests. A little later the dingy skin of the fore-body splits, and through the slit emerges the head and shoulders of the Dragon-fly, followed by the cylindrical hind-body. The creature is limp, as yet its wings are quite short, and there is a lack of the bright colours that will make it conspicuous in flight later. Both hind-body and wings lengthen rapidly and fill out after emergence from the nymph-skin, which now hangs empty where the living nymph fixed its hooks. But the living Dragon-fly has still to hang for a time until its new integuments have hardened and developed their bright tints.

In the meantime we can count the ten broad rings that constitute the hind-body, the last ring bearing a pair of claspers (cercopods); note the greater robustness of the fore-body, to which the wings and legs are attached; and that all the spiny legs are directed forwards. It will be seen, too, that there is an interval between the fore and hind-wings, and that these are all much of the same length. Either wing can be moved independently of the others. They are quite without any folds, and cannot be packed up like the similar textured wings of Beetles and Grasshoppers. They consist of a delicate opaque network covering the entire wing area, whilst the meshes are filled with shining transparent film. The head is attached to the fore-body by so slight a central connection that it has wonderful mobility and can be rotated freely.

As soon as the fully expanded wings and the body integuments are hardened sufficiently to bear the strain of the muscles, the Dragon-fly sets forth on its first flight. It has no need for parental instruction in the use of its wings, but goes off full swoop across the water, its limbs held forwards to act as a net to catch smaller Insects and hold them to the jaws, where wings are lopped and the body eaten. These large, powerful-winged Dragon-flies soon select each a special "beat" or hunting ground—it may be over the waters of the pond in which they spent the early part of their lives, or they may choose a woodland ride or the hedgerows of a green lane. Wherever it be, they range swiftly back and forth along the beat, turning sharply at each end in a manner that would delight the skilful airman; and if one has passed us we have only to wait a few minutes to see it return.

The Dragon-flies of the British Islands number between forty and fifty species; and those of general occurrence may be described briefly. In the large, stout-bodied forms it will be noticed that whilst the fore-wings narrow gradually to the point of attachment to the fore-body, the hind-wings—which are deeper from back to front—narrow very abruptly; and that the very large compound eyes entirely cover the sides of the head and are more or less in contact at the top of the head.

The species are divided into two families with several sub-families and genera. The family Libellulinæ comprises the stout-bodied, and the Agrioninæ the slender-bodied species.

Four-spotted Dragon-fly (*Libellula quadrimaculata*) is one of the most generally encountered of the larger kinds. Head and body measure a little more than an inch and a half, whilst the expanse

of the wings is about two inches and three-quarters. The general colouring is brown, the yellowish sides of the fore-body streaked with black. The four spots of its name are the brown marks in the middle of the front margin of all the wings—a character sufficient to fix its identity, for though many other species have a dark mark not far from the tip of the wings, this central spot is not shared by them. In other parts of the world this species frequently makes long migrations in vast swarms somewhat akin to those of the locusts.

Flat-bodied Dragon-fly (*Libellula depressa*) is the species which is usually stigmatised as a “horse-stinger,” but without a shadow of justification. The hind-body is very broad, flattened above, and in the male is powdered with violet-blue, though that of the female is brown. As in the case of the previous species, the base of the hind-wing bears a triangular patch of brown; but whilst the corresponding part of the fore-wing in *quadrimaculata* has a transparent bar of pale brown, in *depressa* it is of very dark opaque brown. Though found throughout the British Islands, this species is of more local occurrence.

There are two other species with broad hind-bodies powdered with blue in the males; both of local occurrence, but in England only. These are the Tawny Dragon-fly (*Libellula fulva*), with hairy fore-body of a rusty brown colour, the hind-body with a black tip, and a brown patch at base of hind-wings; and the Cross-barred Dragon-fly (*Libellula cancellata*), which has two black bands running down the hind-body, and the base of the wings blackish. The Keeled Dragon-fly (*Orthetrum cærulescens*) also shares this masculine tint; but the hind-body instead of being flat above, slopes from the middle line to each side. This blue

powdering is easily removed if the Insects are not handled with great care.

The Common Sympetrum (*Sympetrum vulgatum*) is the very plentiful yellow-bodied Dragon-fly with a short cylindrical body, flattened beneath, that delights to sit about on clear ground. There are half a dozen other species in the genus, of which several are rare or local. One of the latter is the Red Sympetrum (*Sympetrum sanguineum*), so called because of the colour of the body in the female. The Black Sympetrum (*Sympetrum scoticum*) is much more generally abundant; the male is wholly blackish-olive or full black with the hind-body clubbed; the female is pale yellow-brown, the wings blotched with yellow at the base.

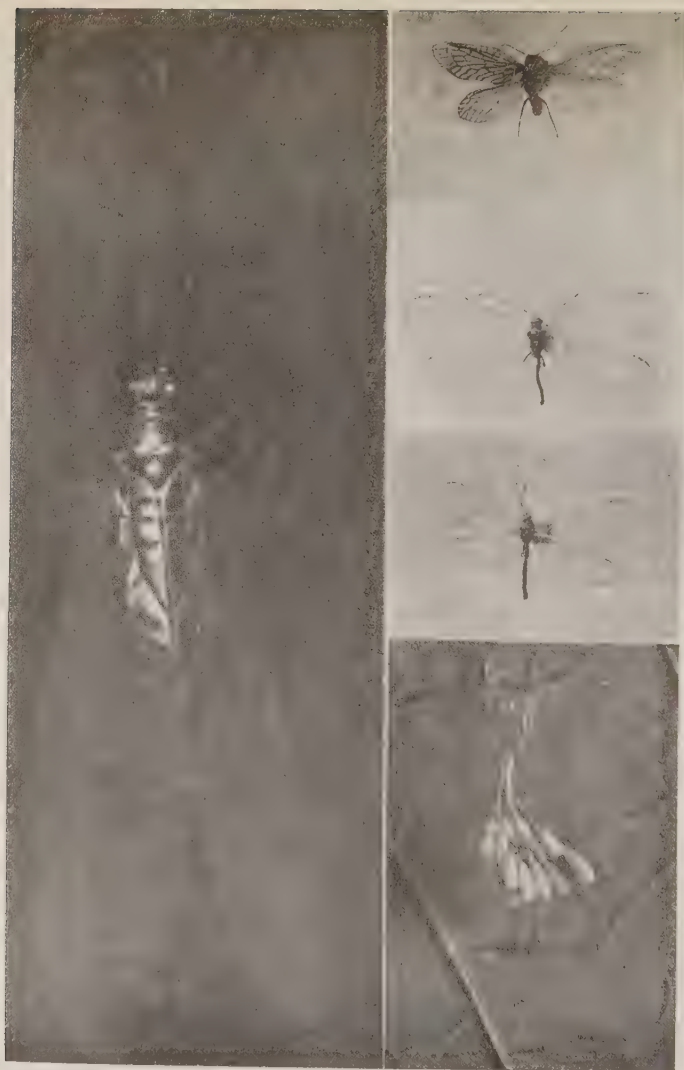
The Dragon-flies with long cylindrical bodies as thick as a ball-room pencil, and wings three to four inches across (*Æschnidæ*), are the ones that chiefly strike the imaginations of the timid, who credit them with extraordinary offensive powers and a willingness to use them. As a matter of fact, so far as man and other backboned creatures are concerned, there is no Insect that is less offensive. It has no sting in its tail, and though its mouth is admirably adapted for the demolition of other Insects, it contains no lancets, or any blood-sucking appliances. They may be caught by hand without any fear of reprisals, though there will be a determined effort for freedom which may involve broken wings if the captive is not held firmly, with the fore-body betwixt finger and thumb. One of the commonest of these is the Blue-spotted *Æschna* (*Æschna cyanea*), with large shining compound eyes, brown and green fore-body, and the long, brown-striped hind-body spotted with greenish-blue. Another common species of similar build, the Large *Æschna* (*Æschna grandis*) may be distinguished



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DRAGON-FLIES.

- 1 Calopteryx splendens, male. 2 Agrion cyathigera.
3 Lestes sponsa. 4 Calopteryx splendens, female.
5 Ischnura elegans.



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LACEWINGS, ETC.

- 1 Golden Eye, enlarged 4 diameters. 2 Orinid-fly. 3, 4 Green Lacewings. 5 Eggs of Lacewings.

from it by its uniform brown coloration, wings included.

The Calopterygidae includes only two British species, both of great beauty, with short, broad heads and prominent eyes. One of these is known by the French name of the Demoiselle (*Calopteryx virgo*), but it is the male that is the more beautiful of the sexes. His slender body is a rich metallic blue, here and there with greenish reflections, and his wings, except a small clearer area at the bases and tips, are smoky-brown showing purple iridescence. The female has the body metallic green, and the delicately netted wings are very pale brown. In the other species, the Shining Demoiselle (*Calopteryx splendens*), the body of the male is a very deep, shining blue, and the nearly clear wings have each a large oval patch of brown which may be dark or pale. The female has a green body, darkening to bronze in the hinder half, and the clear wings are very pale greenish brown. Both species do not occur, as a rule, in one locality.

From the slender-bodied Demoiselles it is an easy transition to the much more delicate, fairy-like Insects of the family Agrionidae. Of these we have over a dozen species, but their specific characters are not sufficiently strong to permit brief descriptions that would enable one to be distinguished from the others. For this, comparison with named specimens is necessary. Although we can see their thin gauzy wings in rapid vibration, the Insects move so lightly and silently that they appear to be wafted like gossamer rather than moved by muscular exertion. Among these is the very familiar *Agrion puella*, with black and blue bands on the hind-body and the fore-body striped with black and yellow. *Pyrrhosoma minium* has the body coloured bright red.

LACEWING-FLIES AND SCORPION-FLIES

AMONG the more familiar of the Insects that visit our gardens in summer is one with four delicate, gauzy, netted wings that are not foldable, of a light green tint with iridescent reflections. Its eyes are of gleaming gold, and it has long, fine antennæ. It flutters to a rose-bush with as little display of weight as a large snowflake exhibits. It is variously known as Lacewing-fly (*Chrysopa perla*), Golden-eye or Stink-fly—the latter because, if one be held in the hollow of the closed hand for a minute or two, it will be found to have infected the hand with an evil odour. Here and there, a gardener knows that this is one of the Insects he must not destroy, for in its larval stage it works incessantly on his behalf, destroying the baneful Green-fly wholesale. Its present business on the rose-bush—whose shoots are coated with Green-fly—is to deposit its pearl-like eggs—pearls of long oval shape. The extraordinary feature of these eggs is that they do not touch the leaf, but are supported by a hair-like footstalk, half an inch long, down which the Lacewing grub has to climb when it has hatched. The Lacewing female begins her work by depositing a minute globule of gum on the leaf, then raising her hind-body as far as she can, the gum is drawn out into a filament which hardens immediately on contact with the air and is sufficiently strong at once to support the

relatively large egg at the top. More than a dozen of these eggs are laid in a group. In the species (*Chrysopa aspersa*), whose eggs are shown, the footstalks are all joined together below; thus spoiling a very pretty and plausible theory that the reason for the eggs having footstalks is to prevent a newly hatched grub from eating the rest of the batch.

The Lacewing's grub is not greatly unlike the grub of the Lady-bird Beetle. It is provided with hollow needle-like jaws which impale the Green-fly, whose juices are then sucked through them. In this way it feeds for about a month, casting its skin when necessary, and then spinning a silken cocoon in which it changes to the chrysalis. In this state it lies snugly all the winter, and in spring cuts through the cocoon with a special pair of jaws provided for this purpose alone.

We have thirteen native species of Lacewing-flies, and two allied Insects of the genus *Nothochrysa*. They are examples of the order Neuroptera or Nerve-veined Insects, the wings consisting of a net-work of nervures, the meshes filled with a filmy membrane, more or less transparent. In this respect they agree generally with the Dragon-flies, which were included in the Neuroptera formerly. The thirteen species of *Chrysopa* do not differ very greatly one from another. They are best identified by comparison; but the two species of *Nothochrysa* may be distinguished from them by their brown colour. But the latter must not be confused with the Insects that have become definitely known by the popular name of Brown Lacewings.

The last named are members of the rather large genus *Hemerobius*, of which there are no fewer than eighteen British species, which are so much

alike also that they can be separated only by a minute examination of the sexual organs. Their bodies are rather shorter than those of *Chrysopa*, and the short joints of their stouter antennæ are more distinct than in the Green Lacewings. When not in use their closed wings form a roof-like ridge over the body. A familiar species is *Hemerobius concinnus*, whose life history is similar to that of *Chrysopa*. In its shorter, broader form the larva reminds one somewhat of the Continental Ant-lion. There are projections from the sides of the body supporting a series of bristles which have a curious use. The larva—known as the Aphis-lion from its unceasing warfare upon Green-fly—sucks its victims dry and empty after the manner of the Green Lacewing's larva, and is said, like that of *Chrysopa alba* shown on Plate 13, to throw them over his head, when they pile up on his back until he is disguised as a little rubbish heap. No doubt, this is with the object of hiding him from an enemy, probably a bird. When ready for pupation he spins a flimsy net-work cocoon and decorates this with the Green-fly remains from his back.

Osmylus chrysopa is a much larger Lacewing, but rare as a British Insect. It measures nearly two inches across the spread wings. The larva feeds upon various Insects, spearing and sucking them after the manner of *Chrysopa* and *Hemerobius* with the Green-fly. It lurks among moss and under stones near the water, and appears sometimes to hunt actually in the water.

The three closely allied species of *Sisyr*a are very minute and little understood Insects. One of them—*Sisyr*a *fuscata*—is believed to feed in the larval stage on the fresh-water sponge, though its very long, hair-like sucking spears appear

hardly suitable for the purpose. It may yet prove that its prey is some other animal found on the sponge.

A group of three minute Insects, the only British representatives of the family Coniopterygidae, constitute the genus *Coniopteryx*. They have powdered white wings which, when fully extended, do not span a third of an inch. A Continental species has been found to feed as a larva on Scale-insects; and our *Coniopteryx psociformis* preys both in the larval and adult conditions on the larvæ of Powder-wings (*Aleurodes*). The antennæ are much longer than the body, and the wings have very few cross-nervures, so that they are much less netted than in the Lacewings. The hind-wings are only about one-fourth the size of the fore-wings.

The Panorpidae or Scorpion-flies are represented in this country by four species only. They have long narrow wings traversed by numerous brown nervures which run mainly lengthwise; the cross-nerves are not very numerous. The wings are free from hairs and shiny, for the most part clear, but blotched with brown at the rounded tip. The Common Scorpion-fly (*Panorpa communis*) has also an irregular zigzag bar of brown crossing the wing at a third from the tip, with several smaller blotches half-way between this bar and the base of the wing. The long slender antennæ are composed of a large number of segments, and the head is continued at a right angle downwards to form a strong beak ending in a pair of crossing mandibles, which they use in preying upon Flies and other Insects. The last three segments of the hind-body of the male are lengthened and the final segment enlarged, so that when he curls these

segments over his hind-body, as is his wont, they produce a strong reminder of the "tail" of the Scorpion; and the popular name of these Flies is due to this fact. The larva is very like a spiny caterpillar, having in addition to the usual three pairs of true legs others of less perfect form, which give it much of the appearance of a Sawfly larva. It appears to feed upon animal and vegetable remains about mouldering tree stumps. An aberrant member of this family is named *Boreus hyemalis*. It has no wings, but there is an extra development of the legs which enables the Insect to leap. It is less than a quarter of an inch long, and looks like a minute grasshopper. It should be sought among moss and under stones during the winter months.

More nearly resembling the Lacewings are the Orl-fly (*Sialis lutaria*) and its near relation *Sialis fuliginosa*, which are our only representatives of the family Sialidæ. The Orl-fly is to be found quite commonly sitting about on streamside vegetation, or flitting weakly as this is disturbed. The squarish head, the antennæ, legs, and body are all black or blackish brown. The yellow-brown wings are coarsely netted in dark brown. It seems to have little purpose in the winged state beyond pairing and depositing its bottle-like grey eggs in rows upon the rushes. In general form the larva is not unlike the larvæ of some of the aquatic Water-beetles. The large head is rather square, and provided with efficient jaws, apparently for the destruction of other Insects in or about the water. In addition to the three pairs of slender legs, its under side is provided with seven pairs of appendages, which look like smaller legs but are really breathing organs. At the end of its larval existence it leaves the water, embeds itself in the

earth, and becomes a pupa. Its life as a winged Insect does not cover many days.

The remaining family of Neuroptera is the Raphidiidæ, represented in this country by four species of Snake-flies, of which only two—*Raphidia notata* and *Raphidia maculicollis*—are at all common Insects. They have a very similar type of wings, but the body is slender and the front part is much drawn out and narrowed, so that it appears like a distinct neck supporting the large head. In the female the body is terminated by a long, sharp ovipositor which gives it some resemblance to a hymenopterous Insect. There is an opaque patch near the tip of each wing, as in many of the Dragon-flies. The larva is of similar form to that of the Orl-fly, but without the respiratory appendages, for it is not aquatic. It lives in rotten wood upon other Insects. It appears to be capable of enduring long fasts when its prey is not available, and is an adept at wriggling backwards quickly.

BEETLES

As the Insects altogether far outnumber every other class of animal life, so the Beetles—the order Coleoptera greatly exceed in the number of species any other order—over one hundred and fifty thousand species being already named and described, a total which is added to largely every year by newly discovered species from the little explored regions of the globe. Among such vast numbers there is, naturally, the greatest diversity of external form, fitting one species or another for life under almost every conceivable condition. Even the three thousand five hundred different kinds of Beetles that are to be found in the British Isles by the diligent seeker exhibit the same variety; and all situations between the seashore and the mountain top—marshes, streams, ponds, fields, lanes, woods, downs and moors, even his dwelling-house—will yield him Beetles of sorts.

With such enormous numbers to deal with, it will be evident that in an introductory work little more can be done than to describe a few of the more frequently encountered Beetles that may serve as types of the eight groups of families into which the order Coleoptera is split up. First of all, however, let us consider what qualifications in an Insect entitle it to the rank of Beetle, for not all the creatures that, by the courtesy of the British Public, are so titled in speech, can claim the distinction.

Beetles are four-winged Insects that undergo complete metamorphosis in their individual progress

from the egg to the winged condition. The body, the antennæ and the jointed limbs of the adult Beetle are all invested in a coating of a horny substance called chitin. The front pair of wings having this horny character in a marked degree are not used in flight, but serve as shields to protect the hinder pair when these are not in use; they are alluded to hereafter as elytra (sheaths). The hindwings are of a thinner, more leathery, substance, and are variously folded in order to pack them securely under the elytra. The latter meet in the middle line of the body, fitting accurately together by their true, straight edges. The mouth is always provided with biting jaws. The antennæ may be either thread-like, clubbed, fan-like, or comb-like. The spiracles or breathing pores are on the back, close to the sides, so that they are always covered by the elytra. Some Beetles are carnivorous, living upon other Insects, others are purely vegetarian, attacking foliage, wood or bark, and many content themselves with decaying substances.

Beetles are variously coloured—some black or of sombre tints, others most brilliantly tinted and with metallic sheen. From this point of view Beetles have not been studied so thoroughly as some other Insects; but there is good reason for supposing that their colours have relation to their habits—that in some cases it is protective, disguising them in the presence of enemies, or warning these enemies that they are unfit for food. Those whose activities in the open take place after sunset are either black or of some dusky tint, whilst those abroad in the hours of sunshine are coloured either to match the brown or grey bark, the bright green of leaves, or—in the event of their being inedible—conspicuously banded or spotted with strongly con-

trasting colours. In only a few British species can the form or coloration be said to mimic that of other Insects, though in exotic Beetles such examples are numerous.

Of the Geodephaga or Earth Gluttons we could have no better examples than the Tiger-beetles (*Cicindela*), for they are great destroyers of living Insects both as larvæ and Beetles. In each of these stages their long, curved and sharp-pointed mandibles are a prominent advertisement of this fact. The larva is a long fleshy grub with large head and fore-body, and on the upper side of the hind-body it has a pair of strong hooks. It digs a well a little larger than its own thickness, and excavates this at a right angle with the surface of the ground. When it has secured a victim it retires to the bottom of this well to dine in privacy, but when ready for another meal it climbs up until its big head and jaws fill the mouth of the hole and so hide it. It is now that the hooks on its back have their principal value, for by sticking them into the wall it maintains its position without effort, and waits until some crawling Insect is passing over it, when the ever-ready jaws seize it. About May and June the perfect Beetles may be seen flying actively in the sunshine, and earning their country name of Sparklers. Catching one in a Butterfly net we find that its elytra are coloured a bright blue-green, each with five spots of dirty yellow. The fore-body and the broad head have metallic golden points mixed with the green. Now, if the pocket-lens is brought to bear upon the elytra, it will be seen that the colour effects are composite: the ground colour is dark blue shagreened with bright green. This is the Common Tiger-beetle (*Cicindela campestris*). A rather larger species (*Cicindela hybrida*) has the ground

colour a very dark chocolate, and on each elytron there are three marks looking as though made with a J-pen dipped in yellow ink. The first of these is at the shoulder, and looks like an inverted comma; at the tip of the elytron is a similar comma lying sideways, and midway between these two is a doubly curved mark extending nearly to the inner margin. A third species is slightly larger again. This is the Wood Tiger (*Cicindela sylvatica*). At first sight very similar, it differs in having a rich black ground and the brighter yellow markings done, as it were, with a finer pen. Moreover, the comma at the tip of the elytron is missing: instead there is a small oblong spot near the outer margin a little farther from the tip.

In districts where snails are fairly plentiful—not necessarily the large, dingy looking snail that abounds under the ivy in gardens—we may come across a neat purple-black Beetle with very convex elytra, a narrowed fore-body and a long slender head continued far in front of the eyes, so that it appears almost like a beak. This is known as the Beaked Cychrus (*Cychrus rostratus*), and it will introduce us to the important family Carabidæ or Ground-beetles. Graceful lines are a characteristic of most of the *Carabidæ*, which are mainly carnivorous and swift-footed Insects that spend most of the day in the earth or under stones and clods. But Cychrus may be found with his head and shoulders pushed far into the shell of a snail, though not with the purpose of securing a hiding-place. He is engaged literally in the business of eating the snail out of house and home.

Any garden or hedgerow will afford us specimens of the Violet Ground-beetle (*Carabus violaceus*), which may be regarded as quite typical of the genus *Carabus*—of which we have ten species—and of the

family Carabidæ. It has much of the grace of Cychrus, a long head, convex hind-body and is apparently wholly black, but the black has a violet tinge, except a rim around the fore-body and hind-body which is violet with a gold reflection. If we look more closely we shall find that these elytra are soldered together as it were, and will not open. There are no wings beneath; and we shall find this condition prevails more or less throughout the genus Carabus. The inference is that these Beetles have been, for ages, so addicted to an underground life, never indulging in flight, that the wings have atrophied and the elytra have grown together. They are most useful coadjutors of the gardener, for while they never interfere with his produce they wage an unceasing warfare upon his hidden foes. This remark applies not only to the genus, but to most of the members of the family Carabidæ. Certain Noctuid Moths, such as the Turnip-moth and the Yellow Underwing, have dull-coloured caterpillars which, after feeding to repletion all night, retire under clods and dead leaves, to elude the watchful gardener. But they cannot so escape from the jaws of the Ground-beetles, who make an end of the destroyers.

One of these Carabid Beetles, though by no means a common Insect, is worthy of mention here on account of its good deeds and its departure from the shape prevailing in the family. This is the Beautiful Searcher (*Calosoma inquistor*). Its hind-body is almost as broad as it is long, and its colour varies from a dark bronzy-green to blackish-purple, the elytra delicately grooved and pitted. The rather flat and dark-coloured larva climbs trees and bushes in search of caterpillars which it uses for its food.

A commoner example of these devouring Insects

is the Big-headed Broscus (*Broscus cephalotes*), which, however, may be found more plentifully along the seashore, where it tunnels in the sand or lurks under stones and seaweed ready to pounce upon any small creature that may be passing. Its big-headed appearance is helped largely by the size and convexity of the fore-body. The entire Insect is black; and the feet and lower divisions of the legs are armed with spiny bristles which help it in obtaining firm hold on the loose ground and in sweeping away sand when it is making a burrow. It is about three-quarters of an inch in length of head and body.

Perhaps more familiar to those who are not specially interested in Insects are the neat, polished little Beetles that are so frequently actively running across paths, attracting attention by their brassy or bronzy metallic colouring which flashes in the sunlight and has earned for them the popular name of "Sunshiners." The writer remembers that as a very small child he was taught that to kill one of these Beetles, even inadvertently, would result in the retirement of the sun behind clouds and the fall of heavy rain. Included under this general name Sunshiner are several kinds of Beetles belonging to the two related genera *Amara* and *Harpalus*. There are nearly thirty species in each of these genera, and it is not always possible to say off-hand which species we are looking at. Small points in the structure or colour of the antennæ, the legs and foot-joints, and in the grooving of the elytra, are the determining factor in many cases; and therefore the eye should always be quick to look out for such differences. The elytra in both genera are finely marked with incisions lengthwise, as clean as though scored with a sharp knife-point. Yet, without a lens, the surface appears quite entire.

To take a common example from each genus, we have one in *Amara familiaris* which is a long oval in form and may be olive or purple-black in colour, but in either case with bronzy reflections from its polished surface. It is only about a third of an inch in the length of head and body; with red legs and darker feet, and the three and a half basal joints of the antennæ red and the remainder black. *Harpalus æneus* is larger, less oval, the fore-body being broadest at the front and the head larger. The fore-parts are black, glossed with green, but the elytra—whose tips appear as though a piece had been cut out—are brilliant brassy green. *Pterostichus cupreus* is also reckoned a Sunshiner. It is of similar proportions, and its colours vary from brassy green to coppery purple or black, head, fore-body and hind-body being of the same tint. The two basal joints of the antennæ are red and the rest black.

Another very common Beetle of this family is *Pterostichus madidus*, which is three-quarters of an inch long and wholly a shining black, except that its legs may be a dark red. The head is large, and the fore-body is narrowed behind, so that the Beetle appears to have a waist. You may find it in the day when turning over stones or clods, but it does not make a voluntary public appearance until night when it goes a-hunting. The distinctly grooved elytra are soldered together, for there are no wings beneath them. There are over twenty species of *Pterostichus* on our list.

In turning over flints and lumps of chalk on the Downs, or stones on the river-shore, we may come across several neat little Beetles about a third of an inch long whose contrasting parts are sure to strike us as distinctive. The hind-body is broadly oval whilst the fore-body is very narrow and longer

than broad, and the head as broad and nearly as large as the fore-body. Head, fore-body, antennæ and legs are all red, but the dull elytra are blue-black and not quite long enough to cover the tip of the hind-body. This Beetle has frequently figured—and deservedly so—in popular accounts of Insect life, sometimes with a little embroidery around the facts. It is known as the Bombardier-beetle (*Brachinus crepitans*) because of its power of blank firing at aggressors. In its hind-body it keeps a small stock of a fluid which when ejected and so brought into contact with the air, rapidly volatilises, producing a tiny cloud of vapour. The ejection is accompanied by a small explosive sound. If the Bombardier is being chased by one of the larger Ground-beetles, such as *Carabus* or *Broscus*, with the intention of devouring the little fellow, the unusual defence is quite sufficient to cause the aggressor to desist from pursuit, but if necessary the firing can be repeated again and again until the reserves of high explosive have been exhausted.

The Hydradephaga, or Water Gluttons, includes most of the Water-beetles—that is to say, those of carnivorous habit. As soon as we reach a pond when the sun is shining some representatives of this group come into view. The brilliant little steely blue oval bodies that rush in circles on the face of the waters are of our commonest species of Whirligig (*Gyrinus natator*). They skim around unceasingly whilst the sun shines, now and then colliding with one of their own kind; but when we reach out a hand or net they instantly disappear by diving. It is not the mere joy of life that causes them to gyrate in this apparently senseless manner. Like the evolutions of the swallows and swifts over the ponds, there is method in the Whirligig's mad-

ness. The surface film holds up many a minute air Insect that has fallen into the pond but is too light to sink. The rapid movements of the little Beetle enable him to seize these before they have time to right themselves. A lucky swoop of the water-net enables us to secure a couple of these Beetles; and though they measure only a quarter of an inch, they are well worth examining in detail, if we are not deterred by their evil odour. Above they are very convex and less so beneath. The short thick antennæ look as though they were merely the stumps from which longer organs have been broken off. The creature appears to have two pairs of compound eyes, which would be highly irregular in any Insect. As a matter of fact each compound eye is divided into two portions to suit the Beetle's mode of life—the upper part enabling him to see along the surface, and the lower and submerged portion giving him a view of the depths. The legs, too, are very peculiar, there being a great disparity between the first pair and those behind. The front legs are normal and are used for manipulating its prey, but the others are very short and flattened to serve as paddles, which explains the very rapid evolutions that attracted our attention. The elytra, which are not long enough to cover the tip of the hind-body, are dotted with very minute punctures in rows, but these are not visible without the aid of a lens. There are usable wings beneath the elytra, which the Whirligig makes use of in migration from pond to pond: a journey it could never accomplish on its legs. There are ten British species of *Gyrinus*, but apart from small differences in size, they are so much alike that they require close examination with the lens in order to separate them.

From the tiny Whirligig we will jump to one of

the largest of the pond Beetles—the Diver (*Dytiscus marginalis*), which is an inch and a quarter long and oval in shape. The sexes are so dissimilar in other respects that they require separate description. The male is olive-black, margined with yellow-brown, and perfectly smooth, even highly polished; the female olive-brown margined with yellow and each elytron scored with ten or eleven deep grooves. Apart from this difference, the sexes may be distinguished by the fore-feet which, in the male, are spread out to form a disc whose under side is studded with suckers to enable him to hold the female. This difference of the fore-feet should be remembered, as occasionally females are found without the grooves in the elytra. Another species, *Dytiscus punctulatus*, is sometimes mistaken for the common species, but may be identified by looking at the under surface, which is black in *punctulatus* and yellow in *marginalis*. There are four species besides those named. The Diver is a most voracious Beetle, and to introduce it to an aquarium, as is sometimes done, means premature death to the other inmates. The larva of the Diver is well known to all who as boys have gone “tiddling” in the ponds, and knew it as the Water-tiger or Water-devil, because of what they saw of its habits. It is a long, spindle-shaped creature with a big head and six long legs. The mouth is closed, but for all that there is a pair of very conspicuous sickle-shaped jaws. The apparent contradiction is explained by the jaws being perforated, and the closed mouth with which they connect can thus act as a pumping chamber. The needle-like points of the jaws being inserted in a victim, its fluids are sucked through them into the mouth. When the Water-tiger has reached its full development, it leaves the water

and hollows out a cell in the bank of the pond, where it changes into the chrysalis state, and about three weeks later emerges as a fully equipped Diver and takes to the water again.

A very similar Beetle, but flatter and only half the size of the Diver, will certainly be found in the same pond. It is not a dwarf form of the Diver, as was explained to me once by an embryo naturalist aged twelve years, with whom I was loath to disagree, but I felt compelled to maintain that it was a distinct species named *Acilius sulcatus*. As I pointed out to him, the elytron of the female instead of having ten deep and narrow grooves, as in *Dytiscus*, has only four shallow but broad channels which, moreover, are lined with rather coarse brown hair. Further, the outline of the Beetle is different, the oval being relatively shorter and broader.

The Smoky Diver (*Colymbetes fuscus*) is a neat, very smooth oval Beetle nearly three-quarters of an inch long, abundant in most ponds. Its head is a brown that looks like black, the fore-body more distinctly brown but very dark with yellow-brown margins, and the elytra are a lighter brown margined like the fore-body. Although these appear to have an uninterrupted polish, if they are examined with the lens they will be found to be finely and closely scored with delicate incised lines from side to side, whilst lengthwise there are three rows of delicate punctures.

Very similar in form to *Colymbetes* are the nineteen British species of *Agabus*, of which we select one of the largest, *Agabus paludosus*, as an illustration. It is half an inch long, smooth and convex, easily slipping through the fingers. The ground colour is yellow, but except the margins of the head, fore-body and elytra, the yellow is masked by a close stippling of very dark brown. There are

three rows lengthwise of punctures on each elytron. The under side is black.

Much more convex above and flatter below is the smaller *Hydrobius fuscipes*, whose colour may be described as black, though when minutely inspected it will be found to be blackish-brown. It differs at sight from all the foregoing in having quite short brown antennæ which have clubbed black tips. The elytra are very minutely punctured and scratched. The only other British species is *Hydrobius oblongus*, distinguished by the absence of scratches on the elytra.

Allied to this, as we may be led to assume by the short, clubbed antennæ, is the Great Water-beetle (*Hydrophilus piceus*), the largest of all the aquatic species and one restricted to the southern half of England. Its length is an inch and three-quarters, and it is entirely black and glossy. It cannot be confused with any other species. Years ago this was a common Beetle in all the ponds of the London district, but the fact became known that unlike the Diver it did not attack and kill all and sundry that came in its way, and it was sought, therefore, by dealers in aquaria : with the result that it is now much less plentiful than formerly. Like several allied species, the female deposits her fifty eggs in a little papery bag which she attaches to water-plants or floats upon the surface. The larva is somewhat like that of the Diver, but larger and of stouter build. In habits they are much alike.

One other type of Water-beetle must be noted before we pass on to some of the other groups. This is a very thick Insect a third of an inch long, differing from all those named in being quite free from polish. Its dull, dark-brown upper side is obscurely mottled with black and finely granulated. Its legs—as well as its thick body—are less adapted

for swimming than for walking on the muddy bottom. Its name is *Pelobius tarda*.

Our next group, the Staphylinidæ, popularly known as Rove-beetles, includes many genera with about eight hundred British species, of which only a few examples can be cited here. Many of them are exceedingly minute. In a rough sort of way these Beetles may be said to resemble Earwigs minus the forceps at the end of the latter's body. This superficial resemblance is due to the shortness of the elytra, which leaves the greater part of the hind-body exposed and capable of being curved up. The wings are of normal length, and when not in use have to be carefully folded to get them safely packed under the small elytra, and the tip of the hind-body is used to assist in this operation. The Beetles will be found in various situations where a long slender body is more helpful than a short thick one—under bark, among moss, between the gills of toadstools and the petals of flowers, some live habitually as commensals in Ants'-nests, and very frequently in summer one of the smaller species is the supposed "Fly" that has got into our eye. Popularly speaking, the best known species is the large Devil's Coach-horse (*Ocypus olens*), which may be met with in the garden or on the wayside, often causing alarm to nervous folk because of its pugnacious attitude. It is an inch long, and of a uniform dull black colour suggestive of mourning. The front of the head is adorned by a pair of formidable jaws; and if a twig is held in its way it will open its jaws widely and seize the obstacle, at the same time curving its hind-body, scorpion-like, over its back and revealing a pair of yellow glands at the tail from which emanates a most objectionable odour. The dullness of the surface of the Beetle is due to a coating of straight hairs which are only

evident by the aid of a lens, except at the edges of the elytra and body segments, where they form a fringe. Both in the larval and Beetle form, this Insect is very predaceous, and destroys large numbers of the gardener's enemies, though few gardeners will believe it. There are ten British species of *Ocypus*.

A closely allied Beetle that some people mistake for the Devil's Coach-horse is the smaller *Creophilus maxillosus*, an error due to form and large jaws rather than to colour, for *Creophilus* has the head and particularly the fore-body polished. The elytra are densely clothed with short pale grey hairs, and margined and fringed with rusty brown hairs. The visible segments of the hind-body, too, are more or less covered with similar hairs, producing a banded effect. This Beetle is much more of a carrion feeder than a hunter, and may be knocked or shaken out of the dead moles and stoats that decorate the gamekeeper's gibbets. It will be noted that the antennæ are much thicker towards their tips than towards the base, whilst those of *Ocypus* are pretty equal throughout. This is the only species. A Beetle that much resembles it, both in form and colour, is the rare *Emus hirtus*; but on comparison of the two it will be seen that *Emus* has enormous jaws, toothed at the middle, and that both head and fore-body are much larger and broader than in *Creophilus*. Head, jaws and fore-body are all very highly polished. It is unnecessary to inquire deeply into the mode of life of a creature with such jaws. "Predaceous" is written large upon them. As a matter of fact, it destroys the larvæ of other Beetles, and makes a special point of hunting for the fat grubs of the Dor-beetle or Lousy Watchman.

By far the largest—in point of numbers—genus

of this great family is *Homalota* with over one hundred and fifty British species, so that wherever we are hunting we are almost certain to come across one or other of them. But they are all very small, black or brown, without any very distinctive marks until we get them under a low power of the microscope.

Many of this family of Beetles will be found as regular inhabitants of Mole-nests and Ant-nests. In the latter there are usually numbers of "hangers-on" in the shape of various Insects—we have already mentioned the case of caterpillars of some of the Blue Butterflies—some of them as parasites or scavengers, others as messmates encouraged by the Ants. Among these is *Lomechusa strumosa*, a reddish-brown Beetle which had not been found in this country by any entomologist between the years 1820 and 1906, when Mr Donisthorpe re-discovered it at Woking. The reason why it had been lost sight of during the intervening eighty-six years is that it spends its entire existence in the nest of the Blood-red Ant (*Formica sanguinea*), and in such nests it is now found repeatedly. This Beetle combines the rôles of parasite and messmate, but the former character prevails it must be confessed, for the Beetle's presence brings about the ultimate ruin of the colony. Except in the matter of legs (Ant-grubs are legless) the Beetle larva is much like that of the Ant, and the Ants appear to accept it as such though it thrives by feeding upon the Ant larvæ. So does the perfect Beetle, which, however, gives something in return. On the upper side of its hind-body it has several glands hidden by tufts of golden hair; and these glands secrete a fluid of which the Ants are fond. Though the Beetle is quite unlike an Ant when set out in a collection,



To face page 112.

LACEWINGS, BEETLES, ETC.

- 1 Larva of Lacewing covered with skins of victims.
- 2 Scorpion-fly. 3 *Boreus hyemalis*, female enlarged.
- 4 Wood Tiger-beetle. 5 Field Tiger-beetle. 6 Violet Ground-beetle. 7 "Sunshiner." 8 *Creophilus*.



For face page 113.

BEETLES.

- 1 Violet Ground-beetle. 2 Spiny-legged Dor-beetle.
- 3 *Necrophorus ruspator*. 4 *Silpha atrata*. 5 Summer
- Chafer. 6 Banded Bee-beetle. 7 *Onthophagus vacca*.
- 8 Seven-spotted Lady-bird. 9 Rose Chafer. 10 Mouse-
- coloured Click-beetle. 11 Glow-worm, male. 12 Glow-
- worm, female.

when alive he so bunches up his body as to present a very passable imitation. In this matter he appears to impose upon the Ants who salute in Ant-fashion when passing, and if he asks for food by means of the appropriate signals they give it to him. In return he allows them to take refreshment from his back.

Another of these Ant-nest Beetles is *Dinarda märkeli*, a wedge-shaped Beetle of which the brown fore-body is the broadest part, the black head very small, the short, red elytra narrower, and the hind-body narrowing sharply to its tips. This species is found in the nest of the large Wood Ant (*Formica rufa*), and its congener *Dinarda dentata* in the nest of *Formica sanguinea*. They, also, have the tufts on the hind-body which are licked by the Ants. *Atemeles emarginatus*, another Beetle of the same family, is common to the nests of several species of Ants. It is a very small Beetle only a sixth of an inch in length—with the small head almost hidden beneath the red-brown fore-body. The dotted elytra are lighter than the fore-body, and the short broad hind-body is black with a red, notched tip. The long legs help the superficial likeness to an Ant. It has rather curious habits apart from the mere fact of lodging in Ants' nests, which may be considered curious in itself. But *Atemeles* appears to be afraid of outstaying its welcome, for it spends the winter with Ants of the genus *Myrmica* and in spring quits them for the home of *Formica fusca*. Its colour scheme blends well with that of its hosts, who appear to have a high opinion of it, carrying its chrysalids to a place of safety if the nest is disturbed.

The allied genus *Myrmedonia*, of which we have eight or nine species, appears to have had these relations with the Ants for ages, for the original

Myrmedonia, the founder of the clan, must have been an Ant associate and transmitted his partiality to all his descendants, who have, in the course of time varied so much as to constitute distinct species all given to the haunting of 'Ants'-nests or the tunnels leading thereto. A typical example of the genus is *Myrmedonia humeralis*, a rather conspicuous Insect though only a quarter of an inch in length. It has a shining black head, broad yellow-brown fore-body, black elytra with brown along the fore-margin; about two-thirds of the hind-body is brown, the remainder black. The long, slender legs are yellow. Its colour scheme consists of alternate bands of black and yellowish-brown, which in combination produce much the effect of the Wood 'Ant's' colour, in whose nest it is found chiefly, though sometimes in that of *Lasius fuliginosus*, the shining black Ant that burrows in rotten wood. But in the latter situations we are more likely to find *Myrmedonia funesta*, whose shiny, sombre-tinted body is more in harmony with its host.

Another of this group of Beetles lives exclusively in the nests of the Hornet and other Wasps. It is one of the larger species, and its name is *Velleius dilatatus*. Owing to the nature of its habitat, the Beetle is rarely seen, and the exact character of its relations to its hosts has not been elucidated with certainty; but probably the larvæ feed upon the grubs of the Hornet, though they may be merely innocent scavengers feeding upon the waste matter that accumulates in such nests.

Among the larger of the Rove-beetles—though much smaller than the Devil's Coach-horse—are several species of *Philonthus* which are very common under stones and decaying vegetation. Among them is the Brazen Philonthus (*P. æneus*),

apparently entirely glossy black, but on closer inspection his head and closely punctured elytra are greenish-bronze and the fore-body dark blue. He is a much brighter Insect than *Philonthus politus* of similar dimensions, which is polished only on the head and fore-body, the elytra and purplish hind-body being dulled by a sprinkling of fine hair. *P. æneus* has a head as large as the fore-body; but in *P. politus* the head is much the smaller of the two first divisions.

A prettily coloured Beetle of cylindrical shape, found under stones on chalk-hills and seashores, is known as *Pæderus littoralis*. It is a quarter of an inch in length, with a shining black head and round red fore-body. The elytra are dark metallic blue, four of the visible segments of the hind-body red and the others black. The yellow legs have a patch of black just above the knees. The description will apply in a general way to *Pæderus riparius* also, but in the latter species the fore-body is longer than broad. There are only four British species in this genus.

The genus *Stenus*, however, has sixty-five native representatives, which agree in having all but the legs wholly black, and the eyes very large and prominent, so large, indeed, that they account for about three-fourths of the head as a whole. The eyes alone are sufficient to indicate the genus. They are fond of damp places, such as the margins of ponds and streams. Many of them are exceedingly minute, and therefore difficult to separate into species, but in the case of five of the larger species one is helped by spots on the elytra. *Stenus bipunctatus*, for example, has a circular dull orange mark about midway in the width of each elytron. Head, fore-body and elytra are all so heavily punctured that the surface

is quite rough. The legs and antennæ are brown. *Stenus biguttatus* is very like it, but the orange spots come nearer to the inner margin of the elytra.

The family Pselaphidæ consists of less than three dozen very minute Beetles which are very likely to be passed over by the novice as mites. They need microscopical examination, and any description to be useful would have to be much longer than the plan of this work would allow. All the same, mention must be made of one—*Claviger testaceus*—a wedge-shaped morsel of reddish-yellow, the head forming the thin end of the wedge. It has no eyes, no wings under the short, broad elytra, and the foot is represented by a single claw. This remarkable Beetle is to be found only in the nest of the Yellow Ant (*Lasius flavus*), where it is an honoured guest, fed and taken care of by the Ants, whose sole return appears to be the privilege of licking off some attractive exudation from its back.

The family Silphidæ is one of considerable interest, including as it does the Burying Beetles (*Necrophorus*), the Carrion Beetles (*Silpha*) and other genera, comprising about one hundred and twelve British species. They vary a good deal in point of size, from very small forms like *Cyrtusa minuta* to the large *Necrophorus humator*. One of the largest of these, the Shore Sexton (*Necrodes littoralis*), is to be found by turning over the bodies of any dead sea-birds that the tide has cast far up the beach, when the Beetles will be found underneath, scraping away the sand to enable the corpse to sink into it and be buried. This species varies in length from half an inch to an inch, and the body and legs are uniformly black. The only bit of colour about it is the club-shaped tip of the antenna, which is dull red. The elytra which

are broader behind and quite cover the body, are strongly ridged. These characters distinguish it from another large species the Black Sexton (*Necrophorus humator*) whose hind-body has more parallel sides, but the last three segments—which are not concealed by the punctured elytra—taper to a point. The club of the antenna is orange-red; otherwise the Beetle is jet black. It is quite a common species if looked for under the dead bodies of birds and small Beetles in fields, woods and roadsides. Our other six Sextons are all marked with bands of red or orange. This contrast of orange and black is an advertisement to insect-eating birds that these Beetles are not edible; the wholly black species are equally objectionable, but as they only fly by night when red or orange is not visible these colours would be useless, so they are not developed. Both the large Sextons mentioned lie low during the day, but the banded species may be seen flying in sunshine in search of the dead bodies which their sense of smell has indicated are ready for burial. As an example of these banded forms we may instance the more familiar Common Burying-beetle (*Necrophorus vespillo*), which has a good deal of yellow hair about it, especially along the front margin of the fore-body and between the thighs on the under side. Moreover, it differs from its congeners in being conspicuously bow-legged so far as the hinder pair of limbs is concerned.

All these Sextons or Burying-beetles pursue a similar course. On finding any small game that requires burying, they first indulge in a meal of the flesh, then get under it and set to work digging the soil with their feet and shovelling it aside with their heads, creating a cavity into which the body drops by its own weight. The original

discoverer of their habits, one Gleditsch, a German naturalist of the eighteenth century, described the Beetles as pulling the corpse down and pressing it down, but that was a mistaken interpretation of what he actually saw. Having got the corpse sunk until its upper surface is two or three inches below the ground level, they industriously cover it in, but not until eggs have been laid all around it. These soon hatch, and the young sluggish larvæ at once set to work feeding upon the store of food provided for them, and continue in this work until full grown, when each hollows out a cell in the ground, changes to a chrysalis and waits for its final transformation to the Beetle stage. These Beetles may be obtained easily in summer by setting baits in the form of dead birds, mice, moles, or the heads of fowls obtained from the local poulterer. These should be taken out to a common, wood, or plantation and secreted under bushes. If visited a few days later, the wished-for Beetles are almost sure to be found about them. As an example of what may be done in this way, it may be mentioned that in the summer of 1920 Mr R. A. R. Priske placed six fowls' heads in a plantation in Richmond Park, and on visiting them a few days later found five out of the seven British species of *Necrophorus* engaged in their burial!

The allied genus *Silpha* includes thirteen British species, and though none of these engages in the burial of dead animals, nearly all of them feed upon carrion. A hollow leg or arm bone of any of the larger mammals or the skull of a small one will, in all probability, yield the collector one of the species which are very flat-bodied, mostly dull black with the surface ridged or wrinkled. One species, *Silpha thoracica*, differs strikingly

from the others in having the fore-body of a scarlet colour. It may be found eating fungi as well as carrion; whilst another, the Beet Carrion-beetle (*Silpha opaca*) is so called because of its depredations in the larval stage on the young foliage of beet and mangolds, in addition to its orthodox food—carrion. At times and in places the beet crop has been entirely destroyed by this pest, whose presence has been explained by the use of manure containing offal which has induced the Beetle to lay its eggs there; then, on this animal matter becoming exhausted, the larvæ have turned to the next best thing, the newly sprouting beet foliage. *Silpha atrata* assists in this work of destruction. The larvæ of all the species differ from the sluggish ones of *Necrophorus* in being very active. They are flat, black or tawny, with the upper side protected by hard plates. *Silpha lævigata* may be found swarming in a dead crab thrown up on the shore, and most of them may be shaken out of the cadavers that hang on the keeper's gibbet.

The nearly related genus *Choleva* has twenty-one species of little oval Beetles with clubbed antennæ, of which several may be beaten out of these same gibbeted criminals; some, however, feed on decaying leaves or the rubbish they find in birds' nests. They are mostly black or brown ovals. A common species among dead leaves is *Choleva velox*, in a rust-red livery, who seems to belie his name *velox* (swift) by pretending to be dead when discovered; but when he considers the proper moment has arrived he gives a demonstration of his running powers, which are of no mean order.

The family Histeridæ also possesses some of these pretended dead ones in the thirteen species of the genus *Hister*—slow, clumsy, little black

Beetles of squarish oval shape, although owing to the Beetle tucking its head under the fore-body, the front edge of the oval appears to be cut square. The highly polished elytra are variously grooved or "striated" with great delicacy, according to the species. The short but powerful legs are withdrawn at a hint of danger, in most cases allowing the highly glossy creature to slip out of sight by gravitation. For this reason they are known as Mimic Beetles in conformity with their scientific name. Some of them are to be found about cow-dung in which their larvæ feed; others, such as *Hister cadaverinus*, have a preference for carrion, and may frequently be shaken out of the moles and stoats on the keeper's gibbet.

Passing over a number of genera of very small Beetles, we must glance at the family Coccinellidæ, for it includes the Lady-birds (*Coccinella*) and some other conspicuous species; altogether about fifty species. The prevailing character in this family is a very convex upper side, of a broad oval or nearly circular outline, the colour red or yellow boldly marked in black—a warning scheme of coloration, indicating to all whom it may concern that if eaten they will do the eater harm. This scheme allows of an enormous amount of difference in the ornamentation of the species and of great variation among individuals that bear the same name, sometimes a Beetle that should have black spots on a red ground has the colours reversed—the spots red on a black ground. We may take as a type of this family the well-known Seven-spot Lady-bird (*Coccinella septempunctata*), which has really four black spots on each red elytron, but the uppermost of these spots join together when the elytra are closed so that they are counted as one. If you take one of these from the rose-bush where it is

busy feeding on Green-fly, you will find that from the joints of its legs there issues a drop of yellow fluid which has a peculiar and unpleasant smell and a very bitter taste ; so that, if an inexperienced bird, who has not yet learned the meaning of black and red marks, takes one of these Lady-birds into its mouth, it will at once feel that the tit-bit it has picked up is not worth keeping. The larva of this Lady-bird is of oval form tapering behind, of a purplish-brown tint, diversified by raised spots of blue, red and black. Its larva-hood lasts about a month, and during the whole of that period it is assiduously engaged in sucking the life-juices from the Green-fly, clearing rose-bushes and hop-vines of the pests with a thoroughness that no human device can equal. At the end of its feeding period the larva attaches itself to the leaf by the tail-end, throws off its skin and reveals the conspicuously spotted chrysalis, from which after a short interval the Lady-bird emerges. The perfect Beetle, like its larva, feeds upon Green-fly. It sometimes happens when our rose-trees or hop-gardens are suffering more than usual from the Green-fly pest that the information reaches the Lady-birds on the Continent, and they migrate here in dense swarms, flying the Channel, and settling down where they are most needed, and laying many eggs. So effectively is the work done that before the larvæ are all full-grown there is not a living Green-fly visible—only empty skins. The danger then is that the larvæ will die of starvation and leave no heirs to carry on the good work next year. But to ensure a succession some of the larvæ now turn cannibals and treat their own kin as though they were large Green-fly. They do not turn cannibals if there are caterpillars available as a substitute for Green-fly. There are several Beetles whose colour

and markings give them a resemblance to Lady-birds, but the whole of the family Coccinellidæ may be known by their antennæ having clubbed tips; their counterfeits have thread-like antennæ.

Representing, among others, the family Endomychidæ, we have a conspicuous Lady-bird-like Beetle of more oval form in *Endomychus coccinea*, which has longer clubbed antenna and a longer fore-body than the Lady-birds. The fore-body has a black centre with scarlet on either side, and the elytra are scarlet with two large black spots on each. The legs are blackish-brown. The larva is not an Insect-eater, but feeds on the fungoid growth about dead wood. Unfortunately, it is not nearly so plentiful in this country as it used to be.

The family Nitidulidæ also have clubbed antennæ, but they are of different form and lack the bright coloration of the Lady-birds. The principal genus is *Meligethes* with thirty-four species, small dark coloured Beetles that swarm on flowers, particularly those of umbelliferous plants, such as hedge-parsley and wild carrot. Two of them, *M. æneus* and *M. viridescens*, have a suggestion of green in the metallic gloss of the fore-body and elytra. The last named is much the greener of the two; all the other species are dull black, and only to be distinguished one from the other by careful work with the lens. *M. æneus* is destructive to the rape crop, the larvæ eating the flowers and so preventing the production of seed for which the crop is grown. The two species of *Soronia*—*S. punctatissima* and *S. grisea*—are much alike, somewhat flattened brown Beetles with a close mottling of darker brown. The larvæ are said to feed upon fermenting sap; but this is not to be obtained everywhere. We have found the Beetles swarming in the burrows of the Goat-moth larvæ,

and suspected them of feeding on the excrement—a suspicion strengthened by the fact that the Beetle-mite is found upon them. A more brilliant member of the family is the Four-spotted Ips (*I. quadripunctata*), whose shining black elytra are made warningly conspicuous by four spots of scarlet. This will be found in pine-woods, often in the crevices of the bark of the pines. The rust-coloured *Pocadius ferrugineus* may be knocked out of decaying puff-balls and other fungi, especially in the southern half of the country.

The typical genus *Mycetophagus* of the small family Mycetophagidæ consists of seven rather small Beetles that live among the fungoid growths of decaying timber. They are mostly black Insects, spotted with red or yellow. *M. quadripustulatus*, which is one of the largest, is only a fifth of an inch in length, with entirely black fore-body, but the more glossy black elytra have four dull red spots, two on each side.

The family Dermestidæ, which has only about sixteen British representatives, includes several that are troublesome to man. As a rule they feed in the larval state on dead animal matter, sometimes in what we might consider too dry a condition to be palatable; but the larva of *Byturus tomentosus* differs in this respect and demands juiciness. It is the little fat, white grub one encounters so frequently when eating raspberries. The Beetle, which is about one-sixth of an inch long, is dark brown, coated with very fine down. The typical genus, *Dermestes*, includes five British species, of which one member, the Bacon-beetle (*D. lardarius*), is only too well known for the damage it inflicts on hams and sides of bacon. If it cannot get such succulent food, it will make shift with dried skins and tendons whether in a museum, a furrier's store

or at the glue factory. It is a dull black Beetle, little more than a quarter of an inch long, and the fore-part of the elytra is made yellowish-grey by a coating of fine hairs. On this grey band there are about six clear spaces giving the appearance of black spots. Another species, the Hide-beetle (*D. vulpinus*) is wholly black with a slight gloss. The elytra are very finely punctured and sparingly coated with minute hairs, whilst the sides of the fore-body have a patch of grey down, and the entire under side is covered with white hairs. This species is a great pest in the skin and fur warehouses; and it is on record that the London merchants in these commodities once jointly offered a reward of £20,000 for a remedy against these Beetles. A peculiar characteristic of the Hide-beetle is that when the larvæ have eaten their fill of skins they burrow into timber and there change into pupæ. We have a piece of wood-work taken from a skin-warehouse in which their tunnels run as closely together as possible; and in these safe retreats there is every security for the continuance of the Beetles in the warehouse with power to deal with every fresh consignment of hides. A third species, *D. murinus*, must be sought for in the dried and hollow carcasses of the keeper's gibbet. After the carrion Beetles have done their work and eaten all the soft muscular tissues, there is still a good meal left in the dry skin and sinews, and these *D. murinus* attends to. In spite of his objectionable surroundings, he is really the prettiest of the three species mentioned, for his black elytra are damascened, so to speak, by an indefinite pattern worked in short fine hairs. The under side is covered densely with dirty white hairs. The larvæ of all these Beetles are covered with long hairs, so that at first sight they might be taken for the cater-

pillars of a Moth. Another member of this family is the Furrier (*Attagenus pello*), whose business, however, is not the preservation but the destruction of furs. The Beetle is something like the *Dermestes*, but smaller, black with three white spots near the hinder edge of the fore-body, and another one in the centre of each elytron. The reddish-brown haired larva matches the fur upon which it feeds. A valuable fur garment laid aside during the warm weather may be converted into a hairless skin by these destructive larvæ. But, probably, the worst member of the family in the opinion of the naturalist is the tiny Museum-beetle (*Anthrenus musæorum*) which finds its way even into air-tight Insect cases and causes havoc, the pretty little larva clad in brushes of stiff hair eating the bodies of our Insects and leaving only the severed wings, the pins and the labels! This work is continued for about a year by the same individual if not previously discovered. The Beetle has the trick of tucking up his legs and appearing like a morsel of lifeless dirt.

Of the next family, the Byrrhidæ, we must mention one of its dozen members, because we are sure to meet with it early in the spring, walking apparently without any specific business in places where rabbits occur. He is oval in form, so convex that his body is as high as it is broad, and when he tucks in his head and withdraws all his legs into grooves provided for the purpose on the under side, he might deceive any Insect hunting bird into the belief that he is merely a rabbit-dropping. Owing to this roundness, he is known as the Pill-beetle (*Byrrhus pilula*). The colour is black, but the upper side is delicately grooved and covered with very minute golden-brown hair which modifies the tint and increases the likeness to the rabbits*

excrement. This, no doubt, is a case of protective resemblance.

The family *Ptinidæ* consists of a number of very small Beetles, of which several are domestic nuisances, getting into our stores of dry food and reducing choice old furniture to dust. Among the latter are *Anobium domesticum*, *Ptilinus pectinicornis* (known by its feathered antennæ), and the so-called Death-watch (*Xestobium tessellatum*) whose sexual clicking was supposed to herald a death. *Anobium paniceum* is best known for its depredations on ship-biscuits by boring into them and reducing them to powder that has passed through their digestive tract. It has an equal fondness for books; and there is on record an indictment against it for boring straight through a set of twenty-seven folio volumes, bindings and all! Several of this group—*Niptus hololeucus*, *Mezium affine* and *Gibbium scotias*—are got up to resemble small spiders or big mites, and these thrive in cupboards where sugar and other food is stored. The last named will get under wall-paper and subsist well upon the dried paste.

The family *Malacodermidæ* includes about forty-six British species of slender, soft-bodied Beetles whose elytra are so thin that they are more or less curled when dry in collections. Several of them are very common, and familiar even to those who take no interest in Beetles. These are the well-known Soldiers and Sailors, and the Glow-worm whose light is better known than the producer of it. They are good fliers, and the Soldiers and Sailors swarm over wayside flowers, whilst the male of the Glow-worm will fly in numbers into the open window of a lighted room on summer nights. To be shown the male Glow-worm (*Lampyrus noctiluca*) is usually a surprise to anyone not a

naturalist who by means of her light has captured the female on a grassy bank; for the female never attains to beetle-shape and is utterly unlike her mate. She, in fact, is little different in appearance from what she was as a larva. The difference is explained by the fact that she does not develop either wings or elytra, and if these organs were pulled off a male there would be little difference between them. The fore-body is very broad, and is rounded in front, so that it looks like a head, but the real head is kept tucked beneath it. The fore-body is brown in the centre with a dull yellow margin; the elytra in the male and the back of the female are coloured brown. In the larval stage they feed upon snails, and the female appears to carry on this work after she has reached her final stage. The male, perhaps, is too much in the air as a Beetle to trouble the snails much. The luminosity that has made the Glow-worm famous attaches to it in some degree throughout life, for even the egg gives out light—probably as a warning of inedibility. The light emanates from three patches on either side towards the extremity of the lower surface. In the larva and the male Beetle these are very small, but in the mature female—the Glow-worm proper—they are large and their light powerful. The Little Glow-worm (*Phosphænus hemipterus*) is wingless in both sexes, and its light-giving power is feeble. It is not at all a common Insect, and the female is found less frequently than the male.

The inexactitude of popular names is illustrated in that of Soldiers and Sailors, the idea being that they are one kind of Insect in different coloured dresses. It covers, however, several of our fifteen species of *Telephorus*, and a few of the neighbouring genus *Rhagonycha*. A very popular writer o!

our boyhood's days attempted to explain the matter by saying that the red species are soldiers and the blue ones sailors. As a matter of fact our species are neither red nor blue. The Soldier (*Telephorus lividus* chiefly) is a light brown, though the centre of the fore-body and the thighs are reddish; and the Sailor (*T. nigricans*) is black, except his fore-body which is reddish with a black centre. All these Telephorids are carnivorous in the larval stage, subsisting on other Insects and worms; and when they have reached the Beetle stage they retain their rapacity, fighting with and feeding upon their kin. They may be found swarming over thistle-heads and other flowers.

The small family Melyridæ may be illustrated by the brilliant little Beetles *Malachius æneus* and *Malachius bipustulatus*, which may be found flying to flowers, their metallic colouring shining brightly. *M. æneus* is a third of an inch in length, with long, slender antennæ and long legs. The fore-body is black with greenish reflections and the front slightly edged with red. The thin elytra are dark crimson, the base margined with dark green which is continued more than half-way down the inner edges. *M. bipustulatus* is smaller, and wholly of a metallic blue-green save for a patch of red at the tip of each elytron.

In the still smaller family Cleridæ we have similarly bright examples in the genera *Necrobia* and *Corynetes*. *Necrobia ruficollis* has a blue-black head and clubbed antennæ, the nearly round fore-body bright red, which colour is continued slightly down the otherwise deep, shining blue elytra. *N. rufipes* is wholly intense shining blue except the legs and the base of the antennæ which are red. Their larvæ appear to feed upon the grubs of Flies, etc. *Corynetes cæruleus* is a brilliant



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BEETLES.

- 1 *Telephorus rusticus*. 2 *T. lividus*. 3 *Nacerdes melanura*.
4 *Oedemera nobilis*. 5 *Donacia cinerea*. 6 *Melasoma longicollis*. 7 *Chrysomela polita*. 8 *Timarcha tenebricosa*.
9 *Chrysomela goettingensis*. 10 *Cassida equestris*.
11 *Blaps mucronata*. 12 *Cassida viridis*.



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LONG-HORNED BEETLES.

- 1 Common Wasp-beetle. 2 Mystic Wasp-beetle. 3 Mullein Wasp-beetle (non-British). 4 *Strangalia armata*. 5 Musk-beetle. 6 *Rhagium inquisitor*. 7 *Strangalia melanura*. 8 *Rhagium bifasciatum*. 9 *Anoplodera sexmaculata*. 10 *Pachyta quadrimaculata*. 11 *Callidium violaceum*. 12 *Pachyta virginia* (non-British). 13 *Pachyta cerambyciformis*. 14 *Leptura livida*.

blue little House-beetle. Its presence may be considered as evidence that some of our woodwork is being eaten by the Death-Watch (*Xestobium*) upon which *Corynetes* wages war.

The most bulky of our Beetles are included in a group of families called Lamellicornia, because three or more of the terminal joints of the antennæ are developed into lamellæ or plates which in repose lie closely one against another forming a club. The family Lucanidæ contains only three British species which are mainly south country Beetles, including the noble Stag-beetle (*Lucanus cervus*), which is very plentiful in some localities during early summer. It is so much larger than any other of our Beetles, and so distinct by reason of its mandibles being developed into a semblance to antlers, that its popular name is sufficient to identify it without any fuller description. Varying in length, the male is commonly two inches; the female smaller because she lacks such excessive development. There is little variety of coloration, the whole animal being of a uniform tint which ranges from chestnut-brown to a brown that is almost black. The larvæ feed in decaying trees for about four years. They are in shape much like the more familiar grubs of the Cockchafer, but larger of course. The pupa reposes in a cell hollowed out of the decayed wood, and changing to the Beetle in winter remains in its cell until June. The Little Stag (*Dorcus parallelipedus*) has nothing to justify the English name beyond being related to the Stag-beetle, and some resemblance to a small-sized female of that species. Its larva has a special fondness for decaying ash trees or stumps. The third species in this family is *Sinodendron cylindricum* whose fore-body and hind-body are of the same width, and as they are very convex, a

cylindrical appearance is given which suggested the name. The fore-body is scooped out in front, and the head bears an upright horn, so that we would like to call this Beetle the Rhinoceros, but remember there is a well-known continental species to which this name has been appropriated for many years. *Sinodendron* is entirely black and glossy. In spite of its high polish, a lens will show us that the fore-body is deeply punctured. The elytra are rugged owing to the longitudinal rows of deep and wide punctures. The larva may be found in the decaying wood of various trees, and is fairly frequent in ash, willow and beech.

The family Scarabæidæ is notable as containing the Sacred Scarab, which, however, does not concern us here, as it does not occur in Britain, but we have some small near relations in the genera *Copris* and *Onthophagus*. *Copris lunaris* is a black Beetle, not much unlike the Dor-beetle or "Lousy Watchman." The fore-body is wider than the elytra and excavated in front into three protuberances, whilst the shovel-like head bears a slender upright horn. It will be found boring into sandy ground beneath dung, upon which it feeds both as a grub and a Beetle. This is our only species of *Copris*, but we have seven species of *Onthophagus*, which are smaller flatter Beetles with something of the appearance of having been trodden on and flattened out, their breadth being disproportionate to their length. The shanks of the legs are strongly developed and on their outer edge run into strong teeth. This is especially so in the first pair of legs, where there are four of these teeth constituting a small rake with which the Beetle scrapes the dung upon which it feeds. *Onthophagus vacca* has the head and fore-body of a dull bronzy-green, and the fore-body is almost as

large as the elytra, which are dull yellow heavily mottled with black and slightly grooved. The male has a sharp horn on the head which is wanting in the female. One small species, *O. ovatus*, is black, but the others are similar in their colour scheme to *O. vacca*, with variations, the ground colour of the elytra being deeper but less hidden by the black mottling. Then, of similar dung-loving habits, are the forty species of *Aphodius*. These are less flattened and of more cylindrical appearance, but we find the head still shovel-like and the front legs powerful and toothed to assist in digging and scraping. One of the largest of the genus is *Aphodius fossor*, which is wholly black and half an inch in length. Many smaller species, however, whilst having the head and fore-body black, have the elytra red or pale brown with punctured grooves, and in some cases marked with short black lines.

The Dor-beetles (*Geotrupes*) are well known through the Lousy Watchman (*G. stercorarius*), who frequently blunders into our face on summer evenings and drops to the ground as though stunned. He is a bulky creature about an inch long and half as much in breadth, wholly black or blue-black on the upper side, with the elytra grooved, but not deeply. As he lies on the ground with his very convex back downwards and kicking vainly in an effort to right himself, we see that his under side is all shining metallic blue; further, that between his legs he is covered with a crowd of mites (*Gamasus coleoptratorum*) that have earned him his rustic name of "lousy." Usually regarded as parasites, they are really friends that keep his corslet bright by eating off the particles of filth that cling to him in his unsavoury occupation. We have said "him," but our last remark applies more to "her," for the female digs deep burrows

under horse or cow-dung and stores them with the material in which she lays her eggs. The larvæ, which are much like those of the Stag-beetle and Cockchafer, hatch out to find themselves in the immediate neighbourhood of sufficient food to serve all their needs. There are two others of similar size and appearance—*G. spiniger* and *G. mutator*. A smaller species, found in the open parts of woods where cattle are grazed, is *G. sylvaticus*. But a more picturesque species, the Lunar Dung-beetle (*G. typhæus*), will be found in early spring on sandy heaths near rabbit feeding-grounds. It is only half the size of the Lousy Watchman, and as you will probably find both sexes at the same time, you may imagine that you have two species; for the male differs in being the possessor of three horns produced straight forward from the front of the fore-body, and often extending well in advance of the head. It feeds upon rabbit droppings, and will be found actively engaged sinking deep shafts in the ground down which it carries this material for the food of its larvæ.

Of the Chafer proper, a very well-known species is the large Cockchafer (*Melolontha vulgaris*) of uniform brown tint, though a delicate coat of down gives it a slightly dusty appearance. About the fore-body and head the down is developed into hair, especially on the under side; and along the sides, just below the edge of the elytra, there are wedge-shaped patches of short white hair. In the male the characteristic fan-shaped antennæ of the group have their highest development among British species (those of the female are smaller). The large larva feeds underground, chiefly on grass-roots, and its hind-body grows so fat that the creature has to lie on its side or on its curled-up end. Its entire feeding period lasts for three years,



COCKCHAFER
Melolontha vulgaris
in 1911

and it often does incalculable damage where the rooks are prevented from digging them up. A smaller and relatively narrower Beetle of similar appearance is the Summer Chafer (*Rhizotrogus solstitialis*), but though its head and fore-body are clothed with yellowish hairs, on the elytra they are very few and scattered. In places these appear on the wing in swarms in the evenings of early summer. The larvæ feed in the roots of oak trees. About one-fourth of the size of the Summer Chafer is the June Bug or Bracken Clock (*Phyllopertha horticola*), which anglers use as a bait under the name of Coch-y-bondhu. Though it has a distinct resemblance to the foregoing the metallic dark green of its head, fore-body and legs render it distinct at once; and as it flies during the hours of bright sunshine, it is a very conspicuous Insect in the years when it is abundant.

Quite distinct, though clearly a Chafer at a glance, is the beautiful Rose-chafer (*Cetonia aurata*), though it is broader in proportion to its length than the Cockchafer and has, consequently, a squarish look. It is endowed with a richness of colouring such as we associate with the Beetles of the tropics, its entire upper side being a golden or coppery green, and although closely dotted with punctures has a very high polish. Its under side is burnished copper without the green reflections. On the elytra are several spots and streaks of dull white, which look as though they had been rather carelessly laid on with a pen dipped in Chinese white. The Beetle gets its popular name from its fondness for rose flowers whose central organs they eat. In the larval state they feed on dead wood, and are sometimes found in the nest of the Wood Ant, where there are many fragments of twigs. There is a handsome black variety. Very similar to,

and often mistaken for the Rose-chafer, is a Beetle called *Gnorimus nobilis*, in which the narrower, rounder fore-body appears more distinct from the hind-body. The elytra are rounded behind, instead of being half-rounded as in *Cetonia*, and the white marks are quite small and short. Clearly allied, though very different in colour, is the Bee-chafer (*Trichius fasciatus*). Its head and fore-body are densely clothed with long yellow-grey hair, and the short, black elytra are crossed by two bold bands of dull ochre connected near the middle line of the back. It gets its name from its resemblance to a Humble-bee as it flies around thistle-heads and other flowers.

The family Elateridæ includes the familiar Click-beetles or Skip-jacks, so-called because some of them have a great tendency to fall on their backs when flying, and their legs being unable to right them, the head and fore-body are jerked back violently with a clicking sound, and the Beetle is lifted from the ground and rights itself. The fairly long antennæ have all the joints much broader in front than behind and so arranged that the inner side of the antenna as a whole appears to be toothed. The fore-body, too, has a distinctive shape, being extended behind into an angle on each side, and the hind-body is long and narrow. The typical genus *Elater* has eleven British species, but with the exception of *Elater balteatus* they are all rare, or at least local. This species, which may be found on birch trees, has black head, fore-body and legs. The elytra are red with black tips. It is little more than a quarter of an inch long. *Melanotus rufipes* is twice this length, and is of a highly polished brownish-black with the somewhat keeled hind-body running gradually almost to a point behind, whilst the legs, as the name indicates, are reddish. The

genus *Athous*, of which we have eight species, run more abruptly to a rounded point behind, and this difference will serve to distinguish the similar *Athous hirtus* from the last named. *Athous hirtus* is wholly black on the head and very convex fore-body, but the elytra and legs are brownish-black. *Athous hæmorrhoidalis* and *A. vittatus* are smaller, brown in colour with the fore-parts darker than the elytra. *A. longicollis* is smaller again, more slender, of a dull yellow tint, with the long, squared fore-body tapering forward. Similar to *Athous*, but smaller, are the half-dozen species of *Agriotes* whose hard-cased, slender larvæ feed on roots and are the wire-worms so detested by the gardener and the agriculturist.

The family Tenebrionidæ includes several Beetles that are familiar in our houses. Most conspicuous of these, because of its superior size, is the Cellar-beetle (*Blaps mucronata*), a long-legged, uniformly dull black Beetle with long legs and an offensive odour. It is remarkable from its elytra being continued far under the sides of the hind-body. They are completely soldered together and by their outer edges to the under side. It inhabits dark places underground and in stables. *Tenebrio molitor*, a slender, parallel-sided, brownish-black Beetle about half an inch long, is, rather curiously, better known as a larva than as a Beetle. In the larval stage it is known as Meal-worm, and as such may be found sometimes in household supplies of flour, bran, etc. It is a long, slender creature of a yellow-brown tint, in lighter and darker rings. Keepers of insectivorous cage-birds deliberately breed these Meal-worms in bran as food for their pets; but they—and the Beetles—may be found in plenty in granaries and flour-mills, as well as in bakers' store-rooms. Several other representatives

of the family have similar tastes in food, among them some that do not belong properly to our fauna, but having been introduced from abroad with foreign wheat, flour, rice, etc., have permanently established themselves, as is too commonly the habit of aliens reaching our hospitable country. So far as these corn-loving Beetles are concerned, it is not at all unlikely that we consume some of them after they have been finely ground up into flour.

The family Pyrochroidæ is represented only by three species of the one genus *Pyrochroa*, which are known as Cardinal Beetles. They are rather "soft-shelled" like the Soldiers and Sailors, but are broader behind and the elytra are silky—due to a fine coat of minute scales similar to those of the Butterfly's wings. The entire upper surface is a fine red, but the legs are brownish-black, as are the antennæ. Most of the joints of the latter have a long projection on the inner side, which converts the antenna as a whole into a comb or rake. On this account one of them is named *Pyrochroa serraticornis* and another *P. pectinicornis*. The whitish larvæ feed in decaying wood; whilst the Beetle may be found flying about flowers.

The family Meloidæ is represented by the Oil-beetles and the Blister-beetle. There are seven Oil-beetles, but six of them are not of everyday occurrence. The seventh, *Meloë proscarabæus*, is not at all uncommon in spring by roadsides, on heaths and along cliff-paths. It is a slow, heavy, blue-black creature, with bloated hind-body which its short, gaping elytra cannot half cover. Its appearance reminds one of a well-developed lad in an Eton jacket; but although the elytra are insufficient as a shield for the hind-body, for the primary purpose of elytra—protection for the more delicate wings—

they are ample, because in *Meloë* there are no wings to be protected. With its slow and laboured movements it would have no chance of escape or defence if assailed by an enemy, but it appears to have no foes. Perhaps it would have but for its trick when molested of pouring out from its joints a reddish, oily-looking fluid which appears to have a repellant property like the yellow fluid of the Lady-bird. They are most likely to suffer from the intolerable pressure of the human foot than in any other way. The male may be distinguished from the female by a glance at the antennæ. Those of the male have a peculiar kink near the middle, owing to the curvature of one of the joints. This Beetle has one of the most remarkable life-stories that can be told even of Insects. The female lays about ten thousand eggs, and if only half of the resulting grubs arrived at full Beetle-hood the Oil-beetles would be among our most plentiful Insects. On the average, however, only two complete Beetles result from that vast speculative production of eggs: nine thousand nine hundred and ninety-eight larvæ failing at some point or other in their career—mostly as infants. The eggs are laid in a hole in the ground, and there hatch out from them minute larvæ with six long legs and considerable activity. These climb up to the nearest flowers where “unerring instinct” tells them to wait for a hairy creature called a Bee and cling hold of its hairs. But instinct has not taught them how to distinguish one hairy creature from another, and whether the hairy visitor be a Beetle, Fly, Moth or—an experimental camel-hair pencil, the larva takes hold. And this is the great tragedy that destroys most of the nine thousand nine hundred and ninety-eight. The larvæ take the wrong turning and perish. The successful ones have had to secure a

special kind of Bee—a Mason-bee (*Anthophora*), and a female—to get conveyed to her nest, to be present when she lays her egg and to slip neatly upon it as it floats on a sea of honey in an earthen cell. The Bee's egg is the only food that will serve it at this stage, and that having been consumed it changes its skin and form and sets to work upon the honey that was stored for the Bee's grub. On this diet it completes its development as a larva, and in turn becomes a pupa and an Oil-beetle. The chances against it, five thousand to one, ought to give it a pretty conceit of itself for winning through.

Another Beetle of the same family—*Sitaris muralis*—has a very similar history. *Sitaris* looks less like a Beetle than does *Meloë*, its thin, narrow elytra not half covering its black and yellow wings, so that it looks like some kind of a fly. But the *Sitaris* larva has not got the dice so heavily loaded against it as *Meloë*, for the female Beetle lays her eggs in the mouth of the Bee's burrow, so that when the new season's Bees emerge from the pupa cells in spring and go off to start housekeeping for themselves the *Sitaris* larvæ are waiting in the hall to cling to them. Unfortunately for them, male Bees emerge first, and many *Sitaris* larvæ come to an untimely end by attaching themselves to the first comers. But even so the risks are so much reduced that the female *Sitaris* has to produce only two thousand eggs to keep up the normal population. Arrived in the Bee's cell the *Sitaris* larva has much the same experience as that of *Meloë*.

The Blister-beetle or Spanish-fly (*Lytta vesicatoria*), which may be met with on ash, lilac or privet in the south or east of England, is a slender, bronze-green Beetle three-quarters of an inch long. Its presence may be detected by a mouse-like odour. An extract from their bodies is used for the purpose

of raising blisters on the human skin, and in solution is said to be effective for raising a new crop of hair on bald heads. Its larva has to find a Bee called *Ceratina* and get carried to its nest in a bramble-stem, where it consumes first the Bee's egg and then the honey, much after the manner of *Meloë* and *Sitaris*, but with some variations in its development.

The great family Cerambycidæ or Long-horned Beetles, of which twelve or thirteen thousand species are known, are but poorly represented in this country by about sixty species. They have long slender bodies and long, thread-like antennæ, in some cases reaching back to the tips of the hind-body—as in the beautiful Musk-beetle—and occasionally far longer—as in the Timberman and the Cobbler. Most of them are far from being common, but several species may be found in summer feeding on the flower-heads of such plants as the cow-parsnip and its allies. In other lands many of these Beetles are of great size. Our largest example is the Tanner (*Prionus coriarius*), a brown-black Beetle about the size of the Stag-beetle, whose fore-body has three sharp points on each side. Its stout antennæ are as long as the hind-body. The large, white larva feeds in oak trees. We have included it here as our largest Longhorn, but it is far from being a common or well-known species. More familiar is the Musk-beetle (*Aromia moschata*), of more slender proportions, and of a shining golden-green colour, whose antennæ are equal to the entire length of the Beetle. It exhales an odour reminiscent of sweet-briar. The larva lives in decaying willow-trunks. A very pretty species is the metallic-blue *Callidium violaceum* that may be found under the bark of dead pine trees where its larva has made shallow borings.

It is about half an inch long and has a broad head and fore-body, in which feature it somewhat resembles the Wasp-beetle (*Clytus arietis*) which, however, is so different in colour that it is utterly unlike. As its name suggests it is boldly marked with black and yellow, black being the ground colour. Although it is not like *the* Wasps, it is certainly mistaken easily for one of the family without particularising as to the species; and the way it flies and walks in the sunshine is very wasp-like. There is little doubt that this counterfeit resemblance often saves its life. A handsome species that can be dug out of decaying tree-stumps is *Rhagium bifasciatum*. It is about three-quarters of an inch long, of a light brown colour striped and clouded with black, each elytron crossed by two curved bands of yellow. The fore-body has a sharp spine on each side. Its congener, *Rhagium inquisitor*, is of similar proportions, but the light ground is somewhat indefinitely dotted with black save for two patches of black between oblique bands of pale brown on the outer margin of the elytra. Its head, antennæ, fore-body and legs are all thickly covered with yellow-grey hairs which lie flat.

Toxotus meridianus has the pale brown elytra broad at the shoulders, tapering to half their width behind, where they darken. Also tapering behind but not so strongly is *Strangalia armata*, with narrow black head and fore-body, and the slightly tapering polished elytra of a brighter yellow ornamented with five strong black spots followed by two black bands. In some examples the first three spots are wholly or partially missing. *Strangalia melanura* is smaller, and the yellow-brown or red-brown elytra are edged with black on the inner margin and have black tips. *Pachyta cerambyciformis* has eight black spots on the dull yellow



MUSK BEETLE
(*Aromia moschata*)
on Hawthorn

elytra, whereof the hinder two unite to form a black tip. *Anoplodera sexguttata* has a more slender, straight-sided body, and is entirely black except six yellow spots on the elytra. *Grammoptera tabacicolor* is a light brown straight-sided Beetle, a third of an inch long, which at a cursory glance might be passed as one of the Soldier and Sailor group, but the different form of the head, fore-body and elytra will on closer inspection dispose of that supposition. *Grammoptera ruficornis* is smaller and wholly black so far as the trunk is concerned, but the antennæ and the base of the thighs are reddish. This species may be found in numbers on May-blossom, and the larva may be found feeding in the wood of the May-tree.

As examples of Longhorns whose antennæ exceed the length of their bodies we may mention *Leiopus nebulosus* with grey elytra clouded with brown. It is only a quarter of an inch long, but the delicate black and red antennæ are nearly half an inch. But the little Timberman (*Acanthocinus ædilis*), which is about three-quarters of an inch long, may have antennæ three inches long—four times the length of head and body. It is the males that are so liberally furnished, but the antennæ of the females are equal to about twice the length of the trunk. As a British Beetle this species is restricted to Scotland, where its larva feeds in the wood of Scots Pine. Almost as well endowed are the Tailor (*Monochammus sartor*) and the Cobbler (*M. sutor*), whose names have been suggested apparently by the long threads they carry as antennæ.

The family Bruchidæ consists—so far as Britain is concerned—of the single genus *Bruchus*, of which we have about a dozen species. They are all small Beetles whose larvæ live in seeds, rendering them useless. Everyone that has ever shelled peas is

acquainted with one of the family—the Pea-beetle (*Bruchus pisi*)—in the larval stage; a fat-looking, long-legged black atom with a white spot at the base of its fore-body. The mother Beetle lays her eggs on the young pod of the pea and the larva makes a long tunnel between its skins and so reaches the inside, where it selects a pea and bores into it. The one pea is sufficient to provide it with food until it becomes a Beetle. Another species (*Bruchus rufimanus*) with black elytra mottled with white and the first pair of feet white, attacks corn, in which it is helped by *Bruchus atomarius*. *B. viciae* prefers the seeds of vetches, and *B. villosus* will be found in the seed-pods of furze.

The large family Chrysomelidæ has nearly two hundred and fifty British species, most of them brightly coloured and shining, with neat forms and antennæ of moderate length. Among them are a score of the genus *Donacia*, whose gold and green and blue forms may be seen on waterside plants. In their larval stage they actually live under water, in the roots of aquatic plants, and as they are not fitted with external gills for the abstraction of oxygen from the water, and cannot come to the surface to obtain it, they ingeniously tap the air vessels of the plant and get their burrows filled with air. There are about a score of species, much alike in size and form, but all beautiful. They are so alike, however, that a description, unless in scientific phraseology, would be of little assistance in distinguishing them. It is another case for comparison of specimens. Some of them have thickened hinder thighs. Of these may be mentioned *Donacia limbata*, bronze-coloured and rather broad at the base of the elytra, which have also a rosy streak along the outer edge. Its hind thighs have a tooth-like projection beneath. But this

feature is more pronounced in *Donacia sericea* and *D. discolor* among others. *D. sericea* is very variable in colour above, one individual being a beautiful deep violet-blue, another a brilliant green, a third bronze, and a fourth ruby-tinted; but it may be known by the coating of silky hairs on the under side. This is one of the commonest species. Some of those that have to be sought on floating leaves out in the pond have two spines under the thigh.

Some brilliant little Beetles in this family are great pests to the agriculturist and market gardener. Thus *Lema melanopa*, a species shaped much like a *Donacia*, but only a quarter of an inch in length, attacks the leaves of wheat and in places does much damage, though its depredations appear to be much greater on the Continent than they are here. It has a red head and legs of the same colour but with darker feet. The elytra are brilliant blue-green; and in the sunshine it is a little gem. Of larger proportions is the Asparagus-beetle (*Crioceris asparagi*), which has a black-spotted red fore-body, black and yellow legs; and the yellow elytra have a strong black band down their junction crossed by three variable black bars. Both the Beetle and its larvæ eat the leaves of the newly sprouting asparagus plant. A more portly species is *Clythra quadripunctata*, which may be found feeding on the leaves of birch, and mistaken for a large and abnormal form of Lady-bird that has become elongated. Its fore-body, head and legs are black; its elytra red with four black spots. The female does up her eggs in packets that look like bits of twig, and drops them from an overhanging branch upon the nest of the Wood-ant. The larvæ live in the nest, feeding upon the vegetable debris of which it is composed.

The nineteen species of the genus *Cryptocephalus* are mostly rare, but there are several little gems among them that may be swept in plenty off the vegetation of the downs. These are sparkling golden-green Beetles that keep their heads tucked away under their fore-bodies, and so to the casual observer the fore-body passes as the head. They have a great liking for bright yellow flowers, especially hawk-weeds and cats-ears, but may also be found in buttercups. It was doubtless of these Beetles that Browning wrote :—

“ Where one small orange cup amassed
Five beetles—blind and green they grope
Among the honey-meal.”

But they are certainly not blind. The most plentiful of these is *Cryptocephalus hypochæridis*, which is about a fifth of an inch long and of bright golden-green, the entire Insect including legs and antennæ sharing in the metallic gloss. Another of similar length but greater breadth has bronzy-green fore-body and the elytra blue-green—in certain aspects the blue is stronger than the green. This is *Cryptocephalus aureolus*. Another, *C. labiatus*, which is found on birch, is entirely black and about half the size of those mentioned.

A quite familiar member of this family is the Bloody-nose Beetle (*Timarcha tenebricosa*), which may be seen in spring and early summer slowly and heavily crawling up the banks of lanes and woods, or climbing the plants upon which it feeds. The entire Insect is of one colour—dull bluish-black—without the slightest suggestion of pattern or other relief visible. The slight exception to this statement appears only on turning the Beetle upside down, when the broadly splayed joints of the foot will be seen to be brown beneath. On viewing

the foot from the side these joints appear as though they had been neatly soled with leather ! Alarmed by our touching him, he pours out of his mouth a red fluid, doubtless to make himself more objectionable to his enemies when the black colour has not warned them off. He is three-quarters of an inch in length, his head tucked under the broad fore-body, and the hind-body is almost round. The elytra are extended down the sides and turned over the margins of the under side. They are completely soldered together ; so we shall never witness the flying of this Beetle. There is a smaller edition of it, so to speak, about half the size, but a distinct species known as *Timarcha violaceoniger*. Of the genus *Chrysomela* we have sixteen species, all built on similar lines to *Timarcha*, and there is a transition in the matter of colour, for *Chrysomela marginalis* is indigo blue with the elytra margined with red. *C. polita*, one of the commonest forms, has the fore-body golden-green and the elytra dark red and highly polished. *C. fastuosa* is a beautiful green with a streak of dark blue along the junction of the elytra. *C. hyperici*, found on St John's-wort, has a golden-green fore-body with the elytra a coppery-green or golden-brown.

There are many other bright and shining examples of this family that deserve notice, but space forbids. A few, however, must be mentioned. The large *Melasoma populi*, with black fore-body and brown elytra, and the smaller *M. longicolle*, whose elytra may be yellow or yellow-brown, may both be shaken from aspen foliage ; the brilliant blue and red *Gastroidea polygoni* on knotgrass ; the brassy *Phyllodecta vitellina* on willows ; and the brown and blue or green *Sermyla halensis* on the Lady's bed-straw.

The Tortoise-beetles (*Cassida*) are so named on account of their broad, depressed shape and the head being entirely hidden beneath the large fore-body which is as wide as the combined elytra. The legs also are mostly hidden or only the little feet showing beyond the wing-cases. There are thirteen British species, of which two green examples are to be met with commonly in appropriate places. *Cassida viridis* is to be found on thistles upon which it feeds both as a larva and a Beetle; whilst the larger and relatively broader *C. equestris* abounds on water-mint and hemp-nettle. The larvæ are quaint creatures that have adopted a remarkable method of disguising themselves. Their bodies are fringed with branched spines, and as a tail they have a long forked appendage which is turned over the back, and on this as a support the excrement is spread out to form a sort of umbrella.

The family Curculionidæ or Weevils has no fewer than four hundred and fifty British species, small, thick-bodied Beetles with the head drawn out to form a beak of varying length and thickness in the different genera; but they have a pronounced family likeness, which is helped greatly by the peculiar form of the antennæ. These are attached to the rostrum, and in the majority of the genera the basal joint is of great length and the remaining joints are "elbowed" to it, so that their clubbed tips are directed forwards. They are all plant feeders, both as legless larvæ and Beetles, and many of them are very destructive to grain and other seeds such as peas and beans. A few are large—half an inch long—but some others are extremely minute. Some are brightly coloured in red, blue or green, but the majority are coloured quietly in browns, greys and black. They abound in summer, and the sweeping-net used on hedge-

row vegetation, nettles, hazel or the flowers of hawthorn will contain specimens at every sweep, or they will tumble into it at every tap on the younger boughs of low trees.

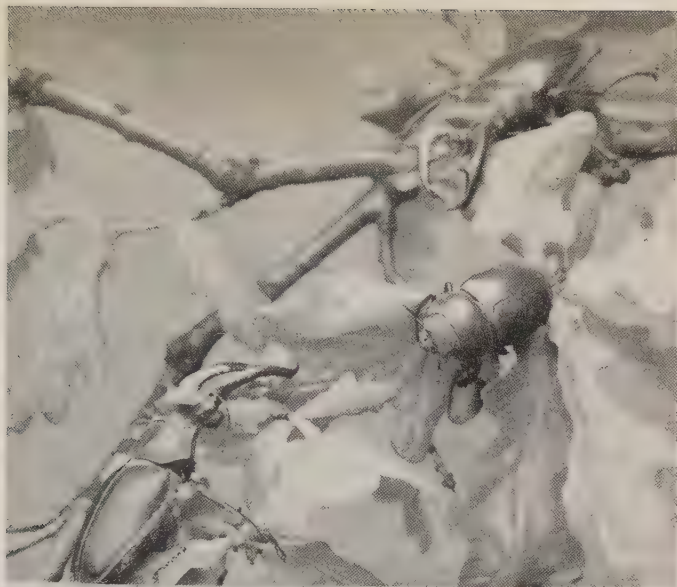
The sub-family Attelabina has but two British representatives, but one of these—*Apoderus coryli*—we may beat from hazel boughs. It is of brick-red colour except the antennæ, head, knees and feet, which are all black. The deeply punctured elytra are square-cut in front and the narrow fore-body (which is of brighter red) has a sort of collar, made more noticeable through the long head narrowing behind. If we look over the hazel bush we shall find that many of the leaves have been carefully cut across from the margins to the midrib and then rolled up cigar-fashion. Remarkable fact that it is, this work has been accomplished by the female of this species, that she may lay her eggs within and that the larvæ may feed on the wilting leaf material. *Rhinomacer attelaboides*, a rounder, more portly looking Beetle of a brighter red, with black head and legs, is our only member of the next sub-family, the Rhinomacerina.

Of the sub-family Rhynchitina we have seventeen species, one of which, *Rhynchites æquatus*, we may get in abundance from any hawthorn. It is of uniform brick-red, only four millimetres in length, of which fully half is supplied by the small head and long, curved rostrum. *Rhynchites pubescens*, twice the size, is shining dark blue, but the head and fore-body are clothed with white down, which is evident also along the sides of the elytra. The coppery *Rhynchites cupreus* causes the premature fall of cherries and plums by cutting their stalks after laying an egg in the fruit. The blue-black *Deporaüs betulæ* serves the leaves of birch in a similar manner to that used by *Apoderus coryli*,

but here the process of cutting and rolling is more complicated, and the end of the tube is always closed by a clever tucking in of part of the leaf.

The Apionina constitute a large sub-family, of which we have seventy-six species in the genus *Apion*. They are all quite small—three or four millimetres in length—and vary in colour: black, blue, red or orange. *Apion craccæ* is blue-black; *A. ulicis*, which may always be found on the seed pods of the furze, is grey; *A. miniatum*, in pretty red jacket, may be found on ragwort flowers.

The Otiorrhynchina include twenty-one British genera, and some of the species are among our largest Weevils. The beak is short and thick, broader at the tip, due to two little ear-like processes at the base of the very long antennæ. *Otiorrhynchus tenebricosus* is eleven millimetres in length, of a uniform black colour, with globular fore-body and the hind-body tapering behind. It will be noted that the Beetles of this genus do not fly, the elytra being soldered together. *O. picipes* is a third less than the last mentioned, but the hind-body is stouter and the tapering behind shows a more abrupt curve. In the former species the body is smooth, but in another large species, *O. sulcatus*, the elytra are strongly grooved and the grooves are coarsely punctured. The colour is greyish-brown. This species has a bad reputation with the gardener as a spoiler of the young shoots of larkspur and chrysanthemum. Of somewhat similar form, but not half the size, is the grey-brown *Strophosomus coryli* that is so abundant on hazel bushes, and is distinctively marked with a short black line where the elytra join. An allied species, but black in colour with a line of metallic



To face page 148.

BEETLES.

- 1 Stag-beetles, male and female. 2 Stag-beetle, male.
3 Cockchafer. 4 Little Stag.



To face page 149.

BEETLES.

- 1 *Dermestes vulpinus*. 2 *Apoderus coryli*. 3 *Cardinal*.
- 4 *Otiorrhynchus picipes*. 5 *Attelabus curculionoides*.
- 6 *Sitaris muralis*. 7 *Phyllobius calcaratus*. 8 *Barynotus*
obscurus. 9 *Metæcus paradoxus*. 10 *Otiorrhynchus tene-*
bricosus. 11 *Hylobius abietis*. 12 *Polydrusus cervinus*.
- 13 *Centhorrhynchus geographicus*. 14 *C. scrophulariæ*.
- 15 *C. hortulanus*. 16 *C. blattariæ*.

pink bordering the elytra, is common on heather : this is *S. lateralis*. *S. coryli* is very destructive in larch plantations.

We have nine species of *Phyllobius*, most of them covered with golden or metallic green scales which gives them an appearance sufficiently pretty to disarm the prejudices of those to whom the mere word Beetle is objectionable. In May and June these bright little Weevils are about on all sorts of vegetation. One we may find on oak is named *Phyllobius oblongus*. Its name is not distinctive, for they are all oblong, but its colour is : the elytra are pale brown, finely punctured in many parallel lines. *Phyllobius calcaratus* is the larger jewelled species that is also plentiful on oak. Its metallic scales differ on separate individuals, so that we may find one light green, another dark green or golden-grey. But however these may vary in tint we may know them for the same species by noting that the under side of all the thighs bears a strong tooth-like projection. Another—*P. urticæ*—black with metallic green and pink scales, lives on stinging-nettle. Two shining pale green species are *P. pomonæ* and *P. viridiæris*, which may be beaten from the same hedgerow vegetation. There is little difference between them, but the critical experts see one in the respective rounding of the fore-body. *Barynotus obscurus* is a comparatively large species (ten millimetres) of a brown colour overlaid with grey scales.

In the sub-family Curculionina we have the large number of forty-eight genera. *Sitones* consists of seventeen British species, small oval Insects of a grey or brown colour, with short, broad beaks, found on clovers, vetches, bird's-foot trefoil, furze and allied plants. The Pine-weevil (*Hylobius abietis*), exceeding half an inch in length, is one of

the giants of his tribe. Rough and black, his sombre livery is brightened by a number of yellow scales laid upon the elytra in curves. The head is almost hidden, sunk into the fore-body. Head and fore-body combined are shaped like a pear, of which the long stout rostrum is the stalk. This Beetle destroys thousands of seedling pines in the nurseries by eating off the bark, and the mischief has often been attributed by uninformed foresters to the teeth of rabbits. The larva feeds on the new layers of wood just under the bark of older trees, and may be found in plenty in the stumps of felled trees. The two species of *Pissodes*—*P. pini* and *P. notatus*—are also great hindrances to pine growers.

Several Weevils of quite distinct form will be found upon the figwort. The hind-body is as broad as long, cut square in front and rounded behind. The narrow fore-body is densely coated with white hair, and the head is sunk into it, so that little of it besides the long slender rostrum is seen. When the Beetle is alarmed it tucks its legs and beak under its body, and the white hair of the fore-body causing this part to disappear, all that is left to view is a very evident seed. Examined with a glass the ornamentation of the elytra will be found quite beautiful. There is a raised band down the junction of the elytra, and three similar bands on each side of it which are all spotted with white. The central band bears two intensely black spots with a little patch of white adjoining. This Weevil is *Cionus scrophulariæ*. There may be two other species—*Cionus hortulanus* and *C. blattariæ*—also on the figwort, but these we can find more surely on mullein. They are grey, spotted with black, and in *C. blattariæ* the ground colour may be silvery white. The larvæ, which feed on the leaves, con-

struct cocoöns which resemble the seed vessels of the figwort.

The family Scolytidæ consists of the Bark-beetles, small species, the majority of which tunnel along the inner layers of bark, though some of them attack the solid wood. They are much like the Weevils, but the rostrum is extremely short and broad, and therefore not very noticeable. Their bodies are cylindrical to suit their tunnelling mode of life; the antennæ short with a thick club. The Elm-bark-beetle (*Scolytus destructor*) is a familiar example by reason of its intricate borings in the bark of sickly elms; but greater damage is done to pine trees by *Hylastes ater* and *Myelophilus piniperda*. *Tomicus typographicus* under ash-bark makes similar excavations to those of *Scolytus*.

GRASSHOPPERS, EARWIGS AND COCKROACHES

ALTHOUGH something like ten thousand species of Insects included in the order Orthoptera have been named and described, only a poor two score of these are regular inhabitants of the British Islands, and of this small number several are naturalised aliens. The chief characteristics of Insects in this order are the possession of two pairs of wings, of which the first pair though not hard like the elytra of Beetles are of firmer texture than, and serve as covers to the more delicate second pair when the Insect is not engaged in flight. At that time the second pair are folded fanwise, and in the case of the Earwigs transversely also. The mouth is well formed for biting and cutting up their food. Ten segments of the hind-body are visible, and the hindmost of these bears a pair of processes known as cercopods. There is no abrupt transformation, the young leaving the egg in the likeness of their parents, except that there are no signs of wings. Of the seven sub-orders into which the Orthoptera are divided only five are represented in our fauna. These are Earwigs (*Forficulodea*); Cockroaches (*Blattodea*); Crickets (*Gryllodea*); Long-horned Grasshoppers (*Locustodea*); Short-horned Grasshoppers (*Acridiodea*).

In the Earwigs the body is long and narrow and the cercopods at its extremity are fashioned into a pair of formidable-looking forceps, which—

though they may inspire respect in some of their enemies—are actively used only for packing up the relatively huge hind-wings under the tiny front pair. To accomplish the safe disposal of these delicate organs the wings have to be folded twice transversely after they have been pleated in their length. In some species, however, the wings are never developed, so that we must conclude that the principal purpose of the cercopods is camouflage. If we view a common Earwig (*Forficula auricularia*) that is hiding its head and fore-body under a stone, in a crevice of bark or in the curled petal of a dahlia, we shall see the hind-body protruding with the cercopods open, presenting the appearance of the head of an aggressive Insect lying in wait for prey. All day it hides in this fashion, for it is a nocturnal Insect. It is more a runner than a flyer, and does not appear to use its wings much, probably chiefly for reaching a new feeding ground or in seeking a mate. According to any gardener, the Earwig's one mission in life is to spoil his best flowers by nibbling the petals; but though damage of this sort must be debited to it, it is probable that it is as much a destroyer of Insects as of flowers. It is frequently to be found in damaged fruit, such as the apples that have been tunnelled by the caterpillar of the Codlin-moth, where its presence may be only partly due to its feeding on the apple, and partly to its having availed itself of the burrow for hiding. It is certainly a general feeder, and the present writer has a grudge against it for the spoiling of several newly developed negatives which were attacked during the night and lines of wet gelatine eaten off the glass. In the male Earwig ten segments of the hind-body can be counted, but in the female only eight are visible. Further, the sexes

may be distinguished by the form of the cercopods. In the female these are nearly straight until near the tips, where they are curved so that the tips cross. In the male the basal portion is flattened out and toothed on its inner edge, and behind they are strongly curved, so that the space enclosed by them is circular. The female has the unusual parental virtue (for an Insect) of watching over her eggs and young. There is a large form, to which the name of var. *forcipata* has been given, in which the body is a little longer and the cercopods twice the length of the normal form. The Common Earwig is found all over Britain.

The Lesser Earwig (*F. minor*) is much smaller, and though widely distributed is only locally abundant. It may be known from the Common Earwig by the inner edge of the cercopods being toothed throughout their length. Another small species, *F. lesnei*, which may be beaten from hedges in the South of England only, is much lighter in colour; the flattened base of the cercopods in the male is longer and the outer edge is delicately haired. This species has no wings.

Along a restricted area of the Hampshire coast, our largest species, the Shore Earwig (*Labidura riparia*) is to be found, but not in any large numbers. It is nearly three times the length and twice the breadth of the Common Earwig, which could be placed within the curved portion of its long cercopods. Its colouring is a pale tint which harmonises with the colour of the sand, and makes the Insect inconspicuous. Two other Earwigs—the Kentish Earwig (*Apterigida albipennis*) and the Ring-legged Earwig (*Anisolabis annulipes*)—are treated as British, but the probability is that they are aliens that have become established locally. They are both larger than the Common

species and wingless. The Kentish Earwig has a single tooth just below the middle of the inner curve of the cercopod; and the Ring-legged Earwig has three white joints in its antennæ and dark rings on the legs. The latter is an indoor species in bakehouses, soapworks, etc. Other aliens have made their appearance from time to time in docks, Kew Gardens and similar establishments, where it is fairly obvious that they have arrived with plants or goods from abroad.

When Cockroaches are mentioned the misnamed "Black-beetle" comes to mind. As its predilection for warm, moist, underground kitchens might lead one to suppose, this is not a true hardy native Insect at all, but an ill-smelling repulsive alien out of the Far East, whose ancestors got a footing here about three centuries ago, and finding it to be a good and a fruitful land for its kind, permanently established itself and spread from house to house. Our truly native Cockroaches—of which we have three species only—are small and unobtrusive, and in consequence are known only to the inquisitive naturalist. They are all distinguished by their flattened form, thin leathery elytra, powerful bases (*coxæ*) of the legs enabling them to run swiftly, bristly shanks, and the great development of the anterior portion (*pronotum*) of the fore-body which forms a covering shield for the rest of that division of the trunk, and ordinarily for tucking the head under, so that the mouth is directed downwards. The antennæ are long and slender, made up of nearly a hundred joints. The wings are wanting in the adults of some species, or in one of the sexes. They are nocturnal in habit, hiding during the day in dark crevices for which their thin form fits them. They are universal feeders, nothing that can be cut up by their jaws

coming amiss, even though it be their own dead. The eggs are packed, like the seeds of a plant, in a horny capsule, which the female pushes into a suitable crevice. The young, which are at first white, are miniatures of their parents, except that there are as yet no indications of wings. In the female of the Common Cockroach these are never developed.

Our native Cockroaches are purely out-of-door Insects, never likely to cause annoyance to the housewife, for they live in bushes and undergrowth, and hide under stones and bark. They are so little seen that they have no English names, and they have been recorded only from the southern part of England. Of the three, *Ectobius lapponicus* is the largest. It is only a third of an inch in length, the male slightly larger than the female, brown in colour, the pronotum with a blackish centre and pale margins. The elytra of the female are not much more than half the length of the hind-body, and the minute wings they cover are of no practical value. *Ectobius perspicillaris* is nearly as large as *E. lapponicus*, from which it may be distinguished by its pale straw-colour and by the pronotum being merely dotted in the centre, with pale margins. The elytra are, in both sexes, longer than the hind-body. *E. panzeri* is also slightly smaller than *E. lapponicus*, pale brown in colour, with the pronotum transparent save for a dark mottling of the centre. This, however, is subject to considerable variation, in some examples the marks being very dark and more or less confluent, in others more scattered. In the females the elytra do not cover half of the hind-body, and the smaller wings are useless. This species does not occur far inland, and is found chiefly along sandy shores from Cornwall to Sussex.



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EARWIGS, COCKROACHES, ETC.

- 1 Common Earwig, female; 2 male. 3 Large Earwig, male. 4 Wingless Earwig, female; 5 male. 6 Common Cockroach, male; 7 female and egg-purse. 8 Croton-bug. 9 *Ectobius perspicillaris*. 10 Australian Cockroach. 11 Bog Grasshopper. 12 Ship Cockroach.



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CRICKETS AND GRASSHOPPERS.

- 1 Mole Cricket. 2 House Cricket. 3 Bog Grasshopper.
4 Field Cricket. 5 Two-coloured Grasshopper.

Of the aliens that have, apparently, taken up their abode with us permanently, there is no need to describe so well known a pest as the Common Cockroach or "Black-beetle" (*Blatta orientalis*), but a few words may be said about the Croton Bug (*Blatella germanica*), which swarms in many warehouses, dwelling-houses and restaurants. It is about half an inch in length, of a pale brown colour; the pronotum yellow in the centre with a dark brown band on each side, outside which the pale margins are dotted with black. It appears to be a native of Central Europe, where it is a woodland insect, and to have been introduced in the first half of the nineteenth century. The Ship Cockroach, which is frequently encountered in warehouses, especially near our ports, is a South American species known as *Periplaneta americana*.

All the foregoing belong to the Running Orthoptera (*Cursoria*). In the remaining three sub-orders of native species the hind pair of legs is developed to serve as leaping organs, and they are known collectively as Orthoptera Saltatoria. The first of these sub-orders is the Gryllodea, represented by four species of Crickets. These have long, slender antennæ and long cercopods, and except in the Mole Cricket the females have long egg-tubes (ovipositors). The elytra as they lie on the hind-body not only cover the wings but wrap the sides closely. The Wood Cricket and the Field Cricket are vegetable feeders, but the Mole Cricket appears to be mainly carnivorous, and the House Cricket is, like the Cockroach, omnivorous.

The Mole Cricket (*Gryllotalpa vulgaris*) is so called from its burrowing habit and the resemblance between its foreparts and those of the Mole. The fore-body, into which the head can be retracted

partially, accounts for about a third of the entire length. It is wider than the hind-body including the closed elytra, and is covered with a fine, short, downy pile which recalls the velvet coat of the Mole. It is coloured a tolerably uniform yellowish-brown, which, however, is lighter on the under parts. The first pair of legs is highly developed into efficient digging instruments, the shank very short and ending in four strong teeth. Over these the three large teeth of the foot work to and fro, cutting through any root-fibres that impede the work of tunnelling. For the Mole Cricket excavates long runs in the earth in its search for grubs. The elytra cover only half of the hind-body, the portion of wings that is left uncovered being folded tightly until in a full-grown individual they look like an additional pair of cercopods. The male has a file-like arrangement on the under side of the elytra, and by rubbing this across the nervures of the opposite elytron, a dull churring note is produced. To enable them to appreciate the calls of their fellows both sexes are furnished with "ears" or auditory chambers in the shanks of the first pair of legs. The hinder pair of legs are developed into leaping organs, but in conformity with this Insect's mode of life not so efficiently as in the other species. The female deposits her yellowish eggs in a special underground chamber. It is a very local Insect, and though there are several records of its occurrence in the North, it may be said to be almost restricted to the South of England.

The Wood Cricket (*Nemobius sylvestris*) is a still less known Insect, owing to the fact that its range in this country is restricted to the New Forest and the Isle of Wight. Its general form is so like that of the House Cricket that it might easily be

passed over as a small example of that species. Its colour is dark brown, and its length is less than half an inch. It may be known by its short rounded elytra which cover only a third of the hind-body, whereas those of the House Cricket may be described as full-size. It is a good runner and leaper, though its leaps are short. The Field Cricket (*Gryllus campestris*) is still more like the House Cricket, but larger (head and body one inch long) and altogether more bulky, of a blackish colour with lighter elytra. It occupies holes in banks, from which it issues to feed upon the plants in the immediate vicinity, but does not appear to stray far from home, and appears to be chary of using either its leaping powers or its wings. Its chirrup is strong and shrill with a ventriloquial quality. Fabre, who had abundant opportunity for comparing it with that of the Cicada of Southern France, says it is as powerful but more pleasing, and even hints that it is finer than the song of the crested lark! Unfortunately, the Field Cricket is one of our rarest Insects, and appears to be found in a few places in the South of England only, between Cornwall and Norfolk.

The House Cricket (*Gryllus domesticus*) is one of those familiar Insects of which it is customary to say that no description is necessary. Still, it is not every house that is sufficiently old or so badly built as to afford them a home. For there can be little doubt that the Cricket is no more a true native than its enemy the Cockroach. Both require the same conditions of warmth and moisture, and cosy crannies in which to spend the day-time. It is about three-quarters of an inch long, with squarish head and fore-body, the elytra lying flat and almost covering the sides of the hind-body. The colour is a pale brown, the fore-parts stippled with black.

The legs and long cercopods are hairy, and the hind shanks have two rows of sharp spines. Like the Cockroach, he is a general feeder, and very thirsty.

The Long-horned Grasshoppers constitute the sub-order Locustodea, but it is only fair to state at the outset that it does not include the Locusts, which are all Short-horns. The Long-horns have in many cases antennæ that reach back beyond the tip of the hind-body, and in any case these organs consist of more than thirty joints. The hind-legs are developed for leaping, and the foot has four joints. The females have a long, conspicuous ovipositor, which they make use of for burying their eggs. The musical instrument of the males consists of a file under the base of the left elytron which works over a ridge on the upper side of the right elytron. They live in trees and bushes, feeding on the foliage, though in some cases Insects are eaten as well or instead. The "ear" is situated as in the Crickets. None of the nine British members of this sub-order can be considered common, whilst most of them are rare or extremely local. Most of them occur only in the South of England, and those of wider distribution are more plentiful south than north. Our largest species is *Tettigonia verrucivora*, the second name being given to it by Linnæus, because in Sweden it is known as the "Wart-biter," the peasants believing that the brown fluid from its mouth burns away warts, so they set the Grasshopper to bite and anoint these excrescences. The head and body measure an inch and a half, and the plump hind-body is half an inch deep. The typical form is green with mottlings of dark brown on the elytra and thighs. The tapering pronotum has a central keel. The hind-legs are splendidly developed for jumping, being nearly



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GRASSHOPPERS.

- 1 "Wart-biter." 2 Great Green Grasshopper. 3 *Meconema thalassina*. 4 Two-coloured Grasshopper.



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GRASSHOPPERS.

- 1 *Stenobothrus lineatus*. 2 *Chorthippus elegans*. 3 *Omocestus viridulus*. 4 *Metrioptera albopunctata*. 5 *Tettigonia bipunctatus*. 6 *T. subulatus*, male; 6 female.

two and a half inches long; and the Wart-biter uses them to good purpose. The wings are shorter than the body.

Of similar length but of more slender shape is the Great Green Grasshopper (*Phasgonura viridissima*) of bright green colour with some brownish markings on the upper surface of the fore-parts. The wings are much longer than the body, and the antennæ extend back to the extremity of the female's long ovipositor. It is more widely distributed in England than the other species, but does not appear to extend to Scotland or Ireland. Our own experience with this Insect leads us to believe that it is more carnivorous than vegetarian. *Leptophyes punctatissima*, a deep green species minutely "peppered" with black, has a short stout body, a liberal equipment of legs and antennæ, but no wings. It may be found on bramble bushes and osiers. *Meconema thalassina* is the beautiful pale green hopper we meet with among the foliage of the oak chiefly. It is only a third of the length of *P. viridissima*, and otherwise distinguished by the pointed crown of its head. Its eggs are laid in the bark of the tree, or in the marble galls. *Conocephalus dorsalis* is another bright green species, with purple-brown elytra. The antennæ are so long that they reach back beyond the toes when the long hind-legs are stretched out straight, as this hopper is accustomed to stretch them when at rest on waterside grasses. The wings are too short to be used in flight. It has been reported only from the southern and eastern counties of England. *Pholidoptera griseoaptera* is yellow-brown with very long and delicate antennæ. The female is wingless, and the male has only apologies for wings. It occurs from Cornwall to Lincolnshire. The three British species of *Metrioptera*,

which complete the list of native Long-horns, are all rare.

The last sub-order, the Short-horned Grasshoppers or Acridiodea, is represented by eleven British species. They all have comparatively short antennæ with not more than thirty joints, but there are several other important points in which they differ from the Long-horns. The males produce their music not by the aid of files on the elytra, but by rubbing beads on the inner side of the great hind thighs over the ridges of the elytra. The "ear," too, is not situated in the front shank, but in the first segment of the hind-body. The elytra are long and narrow, the ovipositor of the females short and adapted for depositing the eggs in the ground. These are covered with a fluid which hardens on exposure and forms a protecting capsule. The foot has only three joints, and there is a pad between the claws. All the Short-horns appear to be vegetarians, and to keep among grasses and other low-growing plants. The sub-order contains all the world's Locusts, though strangely the systematists have given the name Locustodea to the sub-order that contains no Locusts!

Our largest Short-horn, the Bog Grasshopper (*Mecostethus grossus*) is not well known to the public, owing to its habit of frequenting the wettest parts of bogs. It is green above and yellow beneath. The shanks of the hind-legs have a band of black just below their junction with the thigh, and the stout spines on the shank are black also. The thighs are marked with carmine on the under side. Head and body measure three-quarters of an inch; but measured from above with the wings closed, it is an inch. It occurs in the New Forest, the Norfolk fens and the West of Ireland. The White-lined Grasshopper (*Stenobothrus lineatus*) is

of wider range, being recorded from most of the southern counties between Devon and Norfolk. It is of dark green coloration; the keeled pronotum with a raised margin in red that is almost dumb-bell shaped. Its distinctive mark is a white line bordering two-thirds of the length of the elytra, and just beyond this line is a short, curved, white mark. It may be found on grassy hillsides. *Omocestus viridulus*, a smaller but somewhat similar Insect, is without the white marks on the elytra. It is fairly plentiful in all parts of the country. The nearly related *O. rufipes* may be distinguished by the white of the short feelers (*palpi*) near the mouth, the ruddy hind-body and red feet. Although widely distributed it is not so plentiful as the last species. It should be sought in grassy spaces in woods.

One of the two commonest of our Grasshoppers is the Two-coloured Grasshopper (*Stauroderus bicolor*), found in almost every dry field. It varies much in colour according to the general hue of its surroundings: it may be green, rosy or purple-brown. But a distinctive feature will be found in the ridges of the pronotum on each side of the central keel. These ridges, which are wide apart behind, come close together in the middle where they form a sharp angle, and in the space enclosed by the hinder angles there may be two black wedge-shaped marks. The other very plentiful species is the Meadow Grasshopper (*Chorthippus parallelus*) known by the nearly straight ridges of the pronotum which, therefore, are parallel with the keel. Like the last mentioned, its colour varies with its surroundings. This species cannot fly, for though the male has elytra they cover only the stumps of wings, and in the female the elytra also are aborted. *Chorthippus elegans* agrees with it

in the parallel ridges of the pronotum, but is fully winged in both sexes. There is a whitish line along the outer edge of the elytra which may cause it to be confused with *Stenobothrus lineatus*, but it is not so pure a white and is, therefore, not so noticeable. It does not appear to occur farther north than North Wales and Lincolnshire.

Two other species of Short-horns may be known by having their antennæ clubbed at the tip. These are the Red Club-horned Grasshopper (*Gomphocerus rufus*) and the Spotted Club-horned Grasshopper (*G. maculatus*). The former is the larger and less common of the two, and the clubs of the antennæ are more pronounced; moreover, those of the male have white tips. The remaining British Short-horns are two species of *Tetrix*, the so-called Grouse Locusts—quite diminutive, dull-coloured and having the pronotum extended back to the end of the hind-body. The wings are ample, but as the pronotum is a sufficient protection for these when not in use, the elytra are reduced to little oval scales. *Tetrix bipunctatus*, which is the smaller of the two, is common and widely distributed. The pronotum reaches only to the tip of the hind-body. *T. subulatus*, which appears to be restricted to southern England, is of more slender form, and the sharp-pointed pronotum extends a fifth of an inch beyond the hind-body.

BUGS AND PLANT-LICE

THOUGH some people apply the word Bug in a very wide sense that embraces all Insects, there are others who, flying to the opposite extreme, limit it to the single repulsive Insect that attacks sleeping human victims. Although this Bug (*Cimex lectularius*) abounds in houses where cleanliness is not practised inordinately, it is a comfort to feel that it is not a true Briton, though its ancestors settled among us three centuries ago. Owing to the fact that the wings of the Bed-bug are not developed and the elytra represented only by a pair of small pads, it is not a good type of the order of Insects we have now to consider.

The Bugs, with the Frog-hoppers, Scale Insects, Plant-lice, etc., constitute an order that is variously known as Rhynchota and Hemiptera. The chief feature of the entire order is that the mouth, instead of being furnished with cutting jaws, as in the Beetles and Grasshoppers, is fashioned into a jointed beak in which work two pairs of stylets forming a hollow tube. These stylets are thrust through the skin of animals or plants, and by means of an expanding and contracting sucking chamber in the head, blood of animals or juices of plants are sucked up. This beak when not in use is folded under the head with the tip between the bases of the fore-legs. The head is more or less triangular; and the pronotum is well developed. There are usually nine segments of the hind-body visible. Something like eighteen thousand species are known, and of these over a thousand are natives of the British Isles. These are separated into two

sub-orders—the Hemiptera-Heteroptera or Bugs proper, and the Hemiptera-Homoptera including the Frog-hoppers, Plant-lice and Scale Insects.

The true Bugs, or Hemiptera proper, get their name of “half-wings” from the fact that each elytron has the basal portion of a more horny texture than the apical portion which lies over or under its fellow when the wings are at rest. The wings are of more delicate structure, and more or less transparent. Between the bases of the folded elytra there is a conspicuous triangular outgrowth from the fore-body, known as the scutellum, which attains large proportions in some of the families; as its variations or markings have importance in the identification of species it must be remembered. In most cases the wings and elytra lie quite flat on the hind-body, whereas in the Homoptera they form a high central ridge.

Young Bugs leave the egg in much the same form as their parents, except that there is at present no trace of wings, and the scutellum is not developed. The mouth is already a sucking beak, and as the food of the larva or nymph is the same as that of the mature Bug, the development is gradual and not marked by the sudden disclosure of a new form such as we found in the Butterflies and Beetles. The characteristic odour of Bugs is produced by certain glands which have their external openings on the under side of the hind-body near its base in the adult, but on the upper side near the central line in the nymph.

In the family Pentatomidæ or Shield-bugs the scutellum is developed to a large size—in the genus *Eurygaster* it extends quite to the tip of the hind-body and is almost as wide. The Insects have five joints to the antenna, the pronotum broad and often produced at the sides into lobes or spines. *Eury-*

gaster maura has a superficial resemblance to a Tortoise-beetle. It is a pale brown colour, very closely punctured with black. The scutellum, as already noted, reaches to the end of the body, and is so broad that the bases of the elytra are only slightly in evidence from beneath it. The Beetle appearance is heightened by a pale, smooth line down the centre of the scutellum that looks like the junction of a Beetle's elytra. Between this line and the outer margin there is a small pale spot near the base. It is about ten millimetres in length; and may be swept from low vegetation. What is the object of the resemblance to a Beetle is not at all clear. *Sehirus bicolor*, a glossy little black and white Bug, a quarter of an inch long and almost as broad, has the head, pronotum and scutellum blue-black. The front of the pronotum has a broad edge of white, and there are two irregular splashes of white. This and three other species of the same genus may be obtained by sweeping hedgerow herbage, such as nettles, wormwood, ivy, etc., and early in the year they may be found sheltering on the under side of plants close to the ground, such as moss and dog-lichen. The Juniper Bug (*Pentatoma juniperinum*), though generally a rare species, may be found on juniper bushes on the chalk downs. The upper parts are uniformly bright olive-green, thickly punctured with black, except the thin portion of the elytra which is quite transparent. A very fine example of this family, *Tropicoris rufipes*, may be obtained by beating trees and sweeping meadow vegetation. It is of uniform bronzy-brown colour, closely punctured with black, save the tip of the scutellum where is a more or less heart-shaped spot of red. The antennæ and legs are red also. The pronotum is extended on each side into an almost hooked process. Its length

is half an inch. *Picromerus bidens*, of similar build but slightly smaller, has the extensions of the pronotum sharply pointed. The colour is lighter than in the last mentioned species, especially the elytra, and only the extreme tip of the scutellum is touched with red. It may be obtained by sweeping, especially heath and heather.

All the foregoing species have three joints to the foot; but in the genus *Acanthosoma* the feet are two-jointed, the triangular scutellum has a narrow extension behind, and the under side of the hind-body has a distinct keel which is extended forward by a prostrate spine which arises from the second segment and lies between the bases of the second and third pairs of legs. The body is of a longer, tapering form, shortly rounded behind. *Acanthosoma hæmorrhoidale* is half an inch long, of a shining pale brown; all the hard parts punctured except the yellow "tail" of the scutellum. When the wings are expanded in flight the greater part of the hind-body is seen to be crimson barred with black—warning colours. *A. interstinctum*, of similar proportions, but uniformly bronzy-brown, is remarkable for the solicitude displayed by the female for her progeny. She lays from thirty to forty eggs on the leaves of the birch, covers them until they hatch, and then for about a week gives protection to them much as the Earwig cares for her family. The fact was first made known by De Geer, one hundred and fifty years ago, but it has been verified by recent observers. *A. tristriatum*, of green coloration, is found on juniper bushes.

In the family Coreidæ we find Bugs variable in form, with the pronotum broader than the elytra and the hind-body wider behind. The antennæ are thicker and the basal joint stouter than the others. Our example, *Syromastes marginatus*, is a very

distinct and noticeable form, though its dull brown colouring is very uniform, except that the middle joints of the antennæ are red and the shanks of the legs ochreous. The hind-body expands at the sides beyond the elytra. Between the bases of the antennæ there are two little converging spines. This Bug exceeds half an inch in length, and may be found on box trees.

Of the very large family *Lygæidæ* we have eight genera and sixty-two species. A striking representative of this family is a Bug that is known in France as the Beadle and the Soldier (*Pyrrhocoris apterus*), and mentioned sometimes as Fire-bug. It is about a third of an inch in length, and could be described as elliptical in form were it not that the hinder extremity is rounded. Speaking generally, it is of a bright scarlet colour spotted with black. In detail, the head and antennæ are black, also the centre of the pronotum, margined with red. The elytra consist only of the horny portion, the overlapping membrane seldom being developed, and as a rule there are no wings beneath. In some individuals, however, the elytra are fully formed and the wings are developed, so that the name *apterus* may be misleading. The abbreviated elytra are bright scarlet with a large circular black spot in the centre of the broad portion and a small black spot near the base. The hind-body is black with a scarlet border. Although occasionally this Bug occurs in great abundance in some localities, it is not generally distributed; but on the Continent it commonly swarms on trees such as chestnut, lime and elm.

The family *Aradidæ* is noteworthy as containing the flattest and thinnest of our Bugs, a circumstance that fits in with their habit of living under loose bark or between the plates of corky fungi, with which their colouring is in harmony also. They

are small Insects, with short wrinkled antennæ. *Aradus depressus* is little more than a quarter of an inch long, brownish, but the turned-up, ragged margin of the pronotum is marked with white and the elytra are whitish. There are silvery hairs at the tips of the antennæ. This should be sought for under the bark of old tree stumps.

We have only two representatives of the family Hebridæ, and these are so minute that they will scarcely be seen without deliberate search for them—the first, *Hebrus pusillus*, among duckweed, and the second, *H. ruficeps*, among sphagnum. They are only a millimetre and a half long; blackish-brown creatures with the under side clothed with silvery down to entangle air when they enter the water. The antennæ have five joints.

The family Hydrometridæ contain the so-called Water-Gnat and Pond-skaters to be seen skimming the surface of every pond. A more remarkable Bug is *Aëpophilus bonnairei* which spends its life on submerged rocks or under stones on the shore that are only uncovered when the tide goes out. We have taken it on the Cornish coast from a rock that was only exposed at the lowest of spring tides. It lives, apparently, on the marine worms, etc., that frequent such places. It is a small rust-coloured downy Insect, with thick, four-jointed antennæ, red eyes and stout legs. As might be expected from its habitat, the wings and elytra are not developed. The Water-Gnat (*Hydrometra stagnorum*), although only half an inch long, is a remarkable Insect. If its photograph were enlarged a dozen diameters, it might pass very well for that of one of the exotic Stick-insects. The width of the body is about one-twelfth of the length, and the long legs and antennæ are hair-like in their fineness. The head and body are blackish-brown, the legs paler,

and the under side is clothed in silvery velvet. The long head tapers to the eyes, which are at its narrowest part, and then broadens gradually to the remote tip where the antennæ are attached. Its attitude on the surface of the water has suggested its popular name, for it looks like a Gnat at rest with its wings folded over its hind-body : it actually *stands* on the water with its body well above the surface, and walks instead of lying and rowing itself as the Skaters do. Its object is to fall upon and suck the blood of some small aquatic creature.

Of the Skaters (*Gerris*) we have ten native species, but several of these are rare, and one or two others are not to be distinguished from congeners save by comparison of specimens. These Bugs, though built on similar lines to *Hydrometra*, are not so elongated but much broader in proportion to their length. Three of them—*Gerris thoracica*, *G. lacustris* and *G. gibbifera*—are quite common and widely distributed, though the last named does not extend to Scotland or Ireland. *G. thoracica* is readily identified by a yellowish-red patch bordered by black occupying the hinder half of the pronotum. This colour is continued on the elytra, but modified by the strong black nervures. *G. lacustris*, which is slightly smaller and black, has a stronger central keel down the pronotum. The adult may be without either wings or elytra.

The family Reduviidæ, which contains only sixteen British species, includes in the number one that has enjoyed some popularity in books on account of its reputation for feeding upon the pestilent Bed-bug. This is *Reduvius personatus*, a rather large species—three-quarters of an inch long—of a blackish-brown colour and nocturnal habits. It feeds on Flies and other Insects, and has been known to enter the windows of Bed-bug

infested houses and regale itself on these pests. But it is a doubtful ally, for it will not hesitate to drink of human blood direct from its source. It is by no means a common Insect in this country. In its early stages it likes to disguise itself by attaching any available fragments of rubbish and so hiding its real character. All the members of this family have exceedingly fine antennæ, and the short curved beak does not lie close to the under side when at rest. The two species of *Ploiaria*—*P. vagabunda* and *P. culiciformis*—are small, delicately constructed Insects that are very like Gnats, and, no doubt, are passed by as such at times. The first species occurs on various trees, the second in thatch. The heath-frequenting *Coranus subapterus*, a greyish-black form, is remarkable for giving off the scent of ripe pears, instead of the usual Bug odour.

The genus *Nabis* which furnishes ten of the sixteen representatives of the native Reduviidæ, are more Bug-like—taking the Bed-bug as a familiar type—than most. They have more convex hind-bodies with a flat margin, and are usually pale brown in colour. Most of them may be swept from low herbage, but *N. brevipennis* will be found on hazel. One of the commonest species is *N. major*, but a more interesting one is *N. lativentris*, which rarely if ever develops its wings and has the elytra variously shortened. In its earlier stages there is at the base of the hind-body an erect prominence on the upper side rising from a patch of dark colour surrounded by a pallid area which extends to the sides. The effect of this is to make the young Bug appear very like an Ant, and the likeness is even more convincing when the Insect is viewed from the side. The significance of the likeness—whether protective or aggressive—has not been settled satisfactorily.

The slightly convex, oval Bugs of the family Saldidæ are represented by seven species of *Salda*: small dark-coloured Insects with white or yellowish markings, a short, broad head, large prominent eyes, stout antennæ. They vary in length between one-eighth and one-fourth of an inch, and are found on the sea-shore, the salt-marsh and among wet sphagnum around ponds. They are very active, running, leaping and flying when one attempts to catch them, and not hesitating to enter the water in pursuit of prey. *S. littoralis* and *S. pallipes* are common in salt-marshes; *S. saltatoria*, *S. cocksii* and *S. cincta* are plentiful around ponds.

The family Cimicidæ contains only a dozen small British species, with short, broad elytra which leave the hind-body exposed. The beak when not in use lies in a groove beneath the head. In addition to the too well-known "Mahogany Flat" (*Cimex lectularius*), the immigrant that has become naturalised here, there are several true natives. The Pigeon-bug (*C. columbarius*) is smaller than the Bed-bug, but very like it; often swarms in pigeon lofts. The Bat-bug (*C. pipistrellus*), with longer, more pointed hind-body, may be found among the fur of various species of Bat; and the Swallow-bug (*Æciacus hirundinis*), a pale brown Insect, abounds in the nests of the house-martin, often causing dismay in neat, well-kept villas by entering the windows under the nest and being mistaken for the Bed-bug.

The large family Capsidæ includes one hundred and seventy British species, constituting nearly sixty genera. They are soft-bodied, fragile creatures more or less narrowly oval; some, however, very slender and almost parallel-sided. The antennæ are four-jointed, the basal joint much stouter than the others. The elytra and wings are

large, and in most cases fully cover the hind-body. They feed on vegetable juices. In the pale green *Megalocera longicornis* the antennæ are equal in length to the head and body.

In the series of Bug families known as Cryptocerata there appears—only appears—to be a complete absence of antennæ. This is due to the fact that they are all aquatic Insects, and their underwater life would endanger antennæ that were exposed in the usual way; so these Insects, when not flying from pond to pond, keep their antennæ tucked below the eyes, and in some species in special pockets designed for their safe keeping. The family Naucoridæ contains only two British Insects, one of them—*Naucoris cimicoides*—familiar to every boy who has hunted ponds for sticklebacks and newts. It is a broad, flat oval, of olive-brown colour, with the hind-legs flattened and fringed to serve as paddles. The first pair of legs is fashioned very differently: the thighs are exceedingly broad, whilst the shank and the foot—which appear to be one—are short and slender and close down on the thigh to hold prey. It is from half to two-thirds of an inch in length.

The two species of the family Nepidæ are well known also, from the same circumstance. One of these is the very thin, flat and broad Water Scorpion (*Nepa cinerea*) of uniform dull brown coloration. It crawls on the bottom and among weeds, and has no need for adaptation for swimming; but its first pair of legs have the front edge of the broad thigh grooved, so that the curved shank and foot can shut down into it as the blade of a clasp-knife shuts down into its hasp. The beak is very short with a thick base. When the wings are spread, the hind-body is seen to be scarlet above. At the end of the hind-body are two long bristle-like processes which com-

bine to form a siphon through which air is brought to the breathing organs without the Insect exposing itself. In what we may call the Water Stick-insect (*Ranatra linearis*), which is fashioned like a short piece of straw, the front thighs are thinner and longer, but similarly grooved to receive the short shank and foot. The siphon is an inch long, and the hind-body is red, like that of *Nepa*. Like the true Stick-insects, *Ranatra* is endowed with great patience and the power of keeping still until a larva or baby fish comes within reach of its front legs, to have its vital juices sucked.

The family Notonectidæ, though also aquatic, is formed on quite different lines—in fact, on boat-builder's lines. The bulky body is flat beneath, convex and partly keeled above, but as the Boatman (*Notonecta glauca*)—our representative species—swims with its back downwards, the boat shape has purpose. A detailed description is unnecessary, the Insect being as well known as the Water Scorpion, and most persons who are at all observant of Nature have watched and admired the deft way in which the long, flattened hind pair of legs are used as sculls just below the surface of the pond. Our other native member of the family is *Plea minutissima*, too small, perhaps, to have been much noticed; for it is only one-twelfth of an inch long and a little more than half that measure in breadth. It is yellowish-white in colour, and swarms in weedy ponds.

The last family of the true Bugs, the Corixidæ, consists of twenty-five species of *Corixa* and two minute species of *Sigara*, all aquatic. The Corixas, of which several species are common in most ponds, are in outline much like the Boatman, but the back is flat rather than keeled. They propel themselves much after the manner of the Boatman, but back

upwards. Their broad heads are concave behind and the pronotum fits into the concavity, but so loosely that when they are captured one fears the head is coming off. The largest and best known species is *Corixa geoffroyi*, a shining, greenish-black creature, half an inch long; but the other species are only half this length, except *C. coleoptrata*, which is a mere eighth of an inch.

The sub-order Hemiptera-Homoptera is spoken of commonly as Homoptera. In the Insects included there is a difference in the fore-wings that is obvious on comparing a Heteropteron with a Homopteron. In the latter there is no hard area, and the wings slope roof-wise over the back, instead of lying flat. The broad head has the face inflexed so that its front edge comes in contact with the bases of the first pair of legs. The basal joint of the antenna is thickened, the other joints thread-like. In some of the families the larvæ differ in form from the adults. Of the first family, the Cicadidæ, the often large and noisy Insects that are so numerous (eight hundred species) in other lands, we have a solitary small British representative, *Cicadetta montana*, which is found rarely in the New Forest only.

The family Membracidæ is likewise one that is scarcely represented in Britain; but in the tropics Membracids are not only numerous but of extravagant forms. This is due to the fact that the pronotum is extended behind into a long process that may greatly exceed the size of the body, and when viewed from above gives an entirely false idea of the Insect. The hind-legs are developed for leaping. We have only too native species, of which the best known is *Centrotus cornutus*, which is a third of an inch long, of a blackish-brown colour, the wings a lighter brown. The broad head is vertical with the face turned downwards, and above



To face page 176.

BUGS.

- 1 *Acanthosoma interstinctum*. 2 *A. hæmorrhoidalis*.
 3 *Syromastes marginatus*. 4 Elm Sucker (enlarged).
 5 Boatman (enlarged). 6 *Ranatra linearis*. 7 *Evacanthus interruptus* (enlarged).



Go face page 177.

BUGS.

1 Alder Frog-hopper. 2 "Cucko-spit." 3 Horned Membracid. 4 Aphis of Beech. 5 Newstead's Scale-insect. 6 Apple-suckers. 7 Powder-wings of Bramble. 8 Powder-wings of Celandine.

(All enlarged with exception of 6.)

the pronotum rises into a pair of strong, outward-pointing horns, a sharp central keel between them, which is continued along the hood, is almost as long as the body. Head and pronotum are covered with short golden hairs. The hood is not present in the young.

The family Cercopidæ includes a number of Insects that are lumped together popularly under the name of Frog-hoppers. They are of similar form to the Membracids, but there is no backward extension of the pronotum. The broad rounded head has suggested a likeness to the muzzle of the frog, and the hopper component of the name is due to the alacrity with which the Insects leap into the air. The hind shins end in a cluster of spines and bear two spines on their outer face. The soft white or yellow young suck constantly at the juices of the plant and excrete the surplus fluid which they whip into a froth by movements of the tip of the hind-body until there is sufficient of it to hide them and protect them from the sun's rays. It is a doubtful protection, for in its absence the gardener probably would never discover that they were sucking at his best carnations. The mature form of the common species, *Philænus spumarius*, is a yellowish-grey with darker mottling; it does not hide in this manner. It is a quarter of an inch long. *Aphrophora alni*, in other respects very similar, is nearly half an inch long; and *Triecphora sanguinolenta*, like it in size, may be known by its conspicuous warning colours—a shiny black with strong bars and spots of scarlet, a colour scheme reminding one of the Burnet Moth and Cinnabar Moth.

The family Jassidæ consists of Insects very similar to those of the last family, but the shanks of the hind-legs bear rows of many spines. They

are mostly very small Insects, but *Ledra aurita*, the greenish hopper found on oak trees, exceeds half an inch in length. About half that length is the bright little *Evacanthus interruptus*, whose black ground colour is relieved by bold streaks of green.

The family Psyllidæ forms a sort of transition from the comparatively large Frog-hoppers to the Plant-lice. They are quite minute, with clear wings forming a high pitched roof when closed; they have long delicate antennæ of eight to ten joints, and are active leapers. They are found chiefly under the leaves of trees, and are about an eighth of an inch in length. They vary in colour according to the species, and to some extent according to food. The excrement of these, as well as of Plant-lice (*Aphis*), constitutes the sweet sticky substance known as honey-dew. They are very like Plant-lice, though their habit of leaping quickly prevents confusion. They are known generally as Tree-hoppers and Jumping Plant-lice; horticultural writers allude to them as Suckers. Apple, pear and hawthorn trees abound with them: that of the apple being a pale greenish-yellow (*Psylla mali*), that of the hawthorn (*P. peregrina*) greener, and that of the pear (*P. pyri*) dark red. The earlier stages will be found in spring upon the shoots and newly expanded leaves. In *Psylla buxi*, found on box trees, the excrement takes the form of waxy filaments forming a long ribbon, often wound round the Insect. Another species, *Typhlocyba lathierryi*, abounds on elm and bramble. *Livia juncorum* should be sought for on rushes.

The family Aphidæ consists of the true Green-fly or Plant-lice, the Spruce-gall Insect, American Blight, Phylloxera, etc. They are all minute, soft-skinned Insects, with longer legs than the Psyllidæ, longer antennæ of five to seven joints,

and delicate hyaline wings with few nervures, though adults without wings are common. There is usually a pair of wax-secreting tubes on the upper side of the hind-body, which were long supposed to be the source of honey-dew. Parthenogenesis or virgin-birth is a regular method of reproduction at certain times of the year. Green-fly (*Aphis*) comprise many native species, and they are not all green: the *Aphis* of the bean is black, others are brown. In spring and early summer the Green-fly are wingless and imperfect females: they are the product of fertilised eggs laid by sexually perfect females in autumn. As soon as these become fully grown they, without pairing, give birth to living young; and several generations are produced in the same manner. In this way the descendants of a few individuals soon become a countless host which may so weaken the plant upon which it is established that food becomes less abundant. Then a generation appears that develops wings, and the individuals fly to a more juicy plant. Towards autumn a smaller race consisting of sexually perfect males and females are produced: the males winged, the females wingless. After pairing the latter lay eggs, which remain through the winter and hatch in spring. Many species of plants have their particular species of Green-fly. Several kinds of Green-fly are subterranean in habit, attaching themselves to the roots of plants. The females are always wingless; the males frequently so. Some, like *Paracletus cimiciformis*, are found only in Ants'-nests. On many plants they are watched over and protected by the Ants of a neighbouring colony, which collect honey-dew from them and in return destroy the Green-fly's enemies. Among the chief of these, as we have already seen, are Lady-bird Beetles and

their larvæ, and the larvæ of the Lacewing-flies. How important is the work of the Lady-bird, the Lacewing and birds like the Tits, may be realised from the statements of Huxley and Dr Sharp, who calculated, the former that the undisturbed natural increase of the Green-fly for a year would result in "more ponderable substance than in five hundred million of stout men," and the latter that in the course of two or three years the only nutriment left in the world would be from the comparatively few plants that are not attacked by Green-fly.

Green-fly are to be found on plants everywhere; and as we have as many as two hundred species it would be folly in a work of this character to attempt more than the general account we have given above. In this connection it may be mentioned that Mr G. B. Buckton wrote a history of the British species some years ago; and it extends to four volumes! It should be consulted for particulars of individual species. It should be stated, however, that the Vine-aphis (*Phylloxera vastatrix*), which has at times ruined the wine industry in France, is a member of the family, though not a true Briton. Introduced with vines from the United States, it first made its appearance in France and near London in 1863. A near relation (*Phylloxera punctata*) abounds here on the oak, but apparently without doing serious mischief. It is worth hunting for, however, if only to observe the egg-laying of the wingless female on the under side of a leaf. The shining yellow eggs are neatly laid in concentric circles around her. Winged and sexually perfect females appear in autumn, and these appear to lay only a single egg which does not hatch until spring.

Another species (*Chermes abietis*) produces the false cones—really galls—upon the young shoots of the spruce-fir in spring. In the autumn a wing-

less and imperfect female goes into hibernation on the spruce, and in spring lays eggs. The young suck at the new shoots and so produce a many-chambered gall in which they are enclosed until fully grown, when the chambers open and release them. Such as are winged then migrate to larch, where they feed as ordinary Green-fly and produce wingless imperfect females, some of whose winged descendants migrate to spruce and lay eggs that hatch into gall-makers again. Galls are produced by other species of *Aphis* on other plants. Some, like the *Phyllaphis fagi* of the beech, cover themselves with powdery wax.

The family Aleurodidæ consists of Insects that in their adult condition are frequently mistaken for minute Moths. They are popularly known as Powder-wings and Snowy-fly, several of them being known to gardeners as pests. Both sexes are winged as adults, and have antennæ with seven joints. The wings are rounded at their extremity and opaque owing to a coating of wax in the form of powder, with a single nervure running along the centre. With the wings spread they measure about an eighth of an inch across. The female lays a number of elliptical yellow eggs, which stand on short footstalks glued to a leaf. The larvæ on hatching immediately attach themselves to the leaf by their sucking proboscis, and remain until they have acquired wings. Soon a scale develops over the back entirely hiding the larva from view, and under this roof its development proceeds. On the hindmost segment there is a valvular opening from which honey-dew is excreted, which ensures for the Powder-wings the friendship of Ants. We have about a dozen species, all much alike, but differing slightly in the tint of the wings and the dark spots upon them. They may be classed roughly for

present purposes according to these spots. Of the spotless forms we have *Aleurodes proletella* on celandine, *A. phillyreæ* on hawthorn, *A. carpini* on hornbeam, *A. vaporariorum* on tomatoes and cucumber, *A. ribium* on red and black currants, *A. immaculata* on ivy, and *A. rubicola* on bramble. *A. fragariæ* with a single spot on each wing is found on strawberry, *A. spiraeæ* with a forked grey spot on meadow-sweet and bramble, *A. rubi* with a black spot on bramble, *A. avellanæ* with a less distinct yellow spot on hazel, and *A. brassicæ* with two spots on cabbage. Tomatoes under glass in some seasons are ruined by *A. vaporariorum*, the leaves being turned yellow and unable to perform their proper functions of feeding the growing fruit. The Board of Agriculture recommends the use of hydrocyanic acid (prussic acid) for the destruction of the pest; but we think the use of so deadly a poison in connection with food plants is to be deprecated.

The family Coccidæ, which in warmer climates provides us with lac, Chinese white wax and cochineal, has for its chief representatives the Scale-insects and Mealy-bugs that annoy the gardeners and fruit-growers. They are all minute Insects, the females wingless and degraded in form, the males with large fore-wings, much reduced hind-wings and only vestiges of the mouth-parts. The females secrete wax which, combined with excrement and cast skins, hardens into a protective "scale" under which they suck the juices of the plant. These scales vary in form with the species, and are attached to leaves, fruit and bark. The notorious Mussel-scale (*Mytilaspis pomorum*) and the Oyster-scale (*Aspidiotus ostreæformis*) on apple and other fruit trees, are familiar examples. On removing the scale carefully the female will be

found beneath. The Felted Beech-scale (*Cryptococcus fagi*) coats the bark of sickly beeches as with powdered snow. Besides our own native species, our greenhouse plants suffer from many Scale-insects that have been introduced with exotic plants, and the protection from frost afforded by the glass enables them to continue with us. Any greenhouse will furnish some forms, on the leaves of india-rubber plant, camellia, oleander, etc.; and there are a few specimens of *Lecanium hesperidum* on the rind of most of the oranges we handle. Among the most striking of our native forms, on account of their wax coats, may be mentioned Newstead's Scale (*Newsteadia floccosa*) and *Orthezia insignis*. Several species are found frequently in Ants'-nests.

The third sub-order of Hemiptera is known as Anoplura, and consists of the family Pediculidæ or Lice, of which about forty species are attached to distinct species of mammals : three of them parasitic upon man. They are very small, soft-bodied, wingless Insects, with the mouth-parts fashioned into a short tube with a circle of hooks at its free end. With these hooks attachment is made to the skin of its victim and then a finer tube is pushed through it and into the flesh where blood is sucked. The feet end in a single long claw which is hooked on the hairs of their victim. The human parasites are the Head Louse (*Pediculus capitis*), the Body Louse (*P. humanus*) which caused such mischief during the Great War by inoculating our soldiers with trench fever; and the Crab Louse (*Phthirus inguinalis*). Various species of *Hæmatopinus* afflict our domestic animals, as *H. piliferus* on the dog. They must not be confused with the superficially similar, but structurally different Mallophaga or Biting Lice, which have jaws and feed on the hairs and feathers of their victims. (See page 244.)

BEES, WASPS AND ANTS

THE vast assemblage of Insects to which the Bees, Wasps, and Ants belong constitutes the order Hymenoptera, and includes the most highly organised and intelligent of all the Insects. They are exceedingly varied in form and habit and the nature of their food. They agree, however, in the mature Insects possessing two pairs of more or less transparent wings, which are usually narrow, with few nervures, and the hind pair shorter and narrower than the fore-wings. In most of the families there is a row of hooks along the front margin of the hind-wing which catch on a fold of the fore-wing, so that when in use the fore and hind-wings act together. Except in the first three British families the body shows a distinct waist, and one would suppose at a glance that this marks the junction of the fore and hind-bodies, but as we shall see, this is not so. The females have well-developed, and often very conspicuous, egg-tubes or stings. The antennæ are either thread-like or clubbed. The mouth parts are variously adapted, the Sawflies having jaws resembling those of the Beetles, whilst those of the Bees form sucking, brushing and kneading organs. They all pass through four well-defined stages of egg, larva, pupa, and imago like the Butterflies and Beetles: their metamorphosis is said to be complete. The larva may be caterpillar-like as in the Sawflies or maggot-like as in

the Bees, Wasps, Ants, and Ichneumons; but these legless maggots always have heads.

The order is divided into two sub-orders: Sessiliventres in which there is no "waist," and Petiolata in which the "waist" is more or less pronounced.

Of the Sessiliventres or Sawflies, the first family, Cephidæ, consists of the Stem Sawflies, of which a familiar example is the Corn Sawfly (*Cephus pygmæus*), which is only a quarter of an inch in length, with broad head, prominent eyes and antennæ slightly thickened to their tips. The body is black with yellow lines across the hind-body, which ends in a sharp point—the ovipositor. With this instrument the female punctures the joints of the corn stalk, depositing a single egg in each. The young grub makes for the centre of the stem, feeding upon it, with the result that the plant turns yellow and sickly.

The second family, the Siricidæ, are a great contrast to the last named. We have only two species, both of the genus *Sirex*. The Great Horn-tail (*Sirex gigas*) is our largest Hymenopterous Insect, the female measuring nearly an inch and a half without reckoning the stout boring implement, which is not attached to the extremity of the hind-body. The head, fore-body, and four middle segments of the hind-body are black; the antennæ, eyes, legs, and remaining portion of hind-body yellow. The wings are pale brown. The boring apparatus as a whole is an inch long, but half its length is fixed to the under side of the hind-body and its free half is hinged so that it can be used at right angles to the body. It consists of a protecting sheath, and the actual borer which pierces the bark of a pine or fir tree and leaves an egg at the base of the perforation. The trees

selected for treatment are spruce, silver fir, and occasionally larch, and preferably those that are in a sickly condition. It appears never to attack Scots pine. The grub on hatching bores into the solid timber, and in some cases must continue its operations for several years, for the perfect Insect frequently appears from wood that has been used in building. The male is a smaller, more slender Insect without the black band across his hind-body. The Lesser Horn-tail (*Sirex noctilio*) is very distinct from the larger species—though both vary a good deal in the matter of size—being of a uniform polished blue-black except the legs and wings which are pale brown. Its boring apparatus is much shorter than that of *S. gigas*. Its habits are similar, but the trees it selects are Scots pine, silver fir, and occasionally other conifers.

Of the family Tenthredinidæ or Sawflies we have no fewer than four hundred British species, which have been described in detail by Cameron in his *British Phytophagous Hymenoptera* in three volumes. This fact will explain why it is impossible to do more here than give a few main facts about the family, with mention of a few common species. In general form they are much alike. The head is broad with large eyes, the body either flat and broad or cylindrical; the wings are transparent, the first pair longer than the second. The chief characteristic of the family, to which their popular name is due, is the development of the female's egg-placer into a pair of saw-blades (*terebræ*) which cut delicate incisions in plants for the safe lodging of the eggs. The blades, which are exceedingly thin, have one edge set with teeth at regular intervals, and the edges of these teeth are themselves toothed. These slits are, by different species, made in various parts of a plant—in the

leaf-stalk, flower parts, or the margin of the leaf, when these parts are new and tender. Black and yellow are the prevailing tints of the perfect Insects, and the larvæ are conspicuously coloured with yellow, white, black, and blue. These larvæ feed on leaves or fruit, and in most of the genera are like the caterpillars of Moths, except that they have a larger equipment of false legs. Some of them have a trick of curling the end of the body or of elevating it above their backs. Many of them appear to be warningly coloured, and these when quite young feed in company to make their distastefulness—often assisted by slimy secretions—obvious to birds. They usually descend to the ground to spin cocoons for pupation; but some attach these to the plant upon which they have fed. A few of our native Sawflies are as large as Bees, but the majority are much smaller, many of them very small.

One of the best known—because it comes home to everybody who grows a little fruit—is the Gooseberry Sawfly (*Nematus ribesii*) which attacks our gooseberry and currant bushes. The female, which is little more than a quarter of an inch in length, inserts its eggs in the nervures of the leaves, and the black-spotted yellow larvæ lie astride of the edge of the leaf and feed until only the main nervures are left. By the end of May they have finished feeding, and descend to the ground where they construct dark-coloured cocoons and become pupæ. A month later they escape in a winged condition, and the females will impartially lay their eggs on every gooseberry and currant bush in the garden; so that the attack of the second brood proves a far more destructive affair than that of the first brood. Two or three other species of *Nematus* attack the same plants.

The females frequently produce eggs without pairing, and this parthenogenetic brood consists mostly of males. *Nematus abbreviatus* is found on apple and pear trees; and there are a greater number on the various species of willows, some of them making galls in which the larvæ feed. A collection of willow sprigs supporting leaves that have been galled can be grown in water until the perfect Insects emerge. The long galls beside the midrib contain the larvæ of *N. isnocerus*; the pea-like galls on the under side those of *N. bellus*, *N. baccarum* and *N. salicis-cineræ*. The oval galls are those of *N. vesicator* and *N. gallicola*, and in similar galls on sallow will be found the larvæ of *N. bridgmanni*. *N. erichsoni* is destructive to larch by eating the foliage of the new shoots. Then there is the Plum Sawfly (*Hoplocampa fulvicornis*) which lays an egg in the plum or damson flower, with the result that soon after the fruit is formed there is a reddish-white larva feeding on the young kernel, leading to the early fall of the deformed fruit.

The notorious Black Jack or Nigger (*Athalia spinarum*) that reduces the leaves of the turnip to skeletons is the larva of another Sawfly. In this stage it has a black back with paler sides spotted with black, but in the winged condition it has black head and antennæ, yellow-brown body and transparent wings. By their wholesale destruction of the leaves they sometimes render a field of turnips valueless. There are three broods in the year.

One of our finest Sawflies is *Cimbex femorata*, a rare species but too noteworthy to be omitted. A bluish-black creature nearly an inch long with broad body, it has the antennæ strongly clubbed, and the otherwise clear wings margined with

brown. Apart from the colour of the body, it presents a close superficial resemblance to the Narrow-bordered Bee Hawk-moth (*Hemaris fuciformis*). The larva may be found on the leaves of birch. The Pine Sawfly (*Pteronus pini*) attacks the Scots pine, eating the needles of the new shoots. The black male has plumed antennæ. The female has black head, antennæ, fore-body, and a black patch in the centre of the yellow hind-body. *Pteronus rufa* and several allied species assist in the destructive work.

Roses suffer greatly from the attentions of Sawfly larvæ, quite a number of species uniting their forces to keep the rose-grower alert. *Hylotoma rosæ* is the chief of these depredators, the larva being known amongst the others by its blue-green colour, with a line of yellow spots down the middle of the back and black spots along the sides. The perfect Insect is dull yellow with black head and yellow legs. *Blennocampa pusilla* has a short green larva that seeks to evade observation by turning down the edge of the leaf and feeding under it. Then there is the "Rose Slug" (*Eriocampa rosæ*) allied to the "Slug-worm" (*E. limacina*) of pear and cherry. These slug-worms are Sawfly larvæ that are somewhat slug-shaped and cover themselves with slime or a resinous secretion. We have several species. Larvæ of the genus *Lyda* combine to spin a large covering web over the leaves of the shoot they have determined to destroy, and within this communal tent each constructs a tube to protect its own body while it feeds.

The Poplar Sawfly (*Cladius viminalis*) cuts pockets in the leaf-stalk of the poplar to accommodate her eggs, and the warningly coloured orange and black larvæ feed side by side to give

better advertisement of their inedibility. They spin yellow double cocoons under loose bark. The larvæ that swarm on Solomon's-seal and rapidly reduce the leafy shoots to ragged skeletons are those of the Sawfly *Phymatocera aterrima*, and the mealy grubs on the leaves of alder are those of *Pæcilosoma pulveratum*. A Sawfly similar to *Cimbex* (already mentioned) may be found swarming on hawthorn hedges, where in winter its large cocoons attached to the branches are conspicuous. This is *Trichiosoma tibialis*. The perfect Insect is shiny black and has clubbed antennæ and brown-margined wings like *Cimbex*.

The second great division of the Hymenoptera is known as the Petiolata from the fore-body and hind-body appearing to be connected by a slender stalk. As a matter of fact the whole of this "petiole" and its connection to the fore-body is part of the hind-body. The Petiolata in turn is divided into three sections: Parasitica, including the Gall-flies, Ichneumon-flies and Fairy-flies; Tubulifera, consisting of the Ruby-wasps, themselves parasites; and Aculeata, including all kinds of Bees, Wasps and Ants.

Of the Parasitica we have representatives of six families, several of them with a very large number of species, from which we must be content with a few examples. The Gall-flies constitute the family Cynipidæ. Galls are due to mechanical or chemical irritation set up by the introduction of the Gall-fly's egg among the living tissues of a plant. It has been variously suggested that the abnormal growth of vegetable tissue is sufficiently explained by the presence of the foreign object (the egg), and that it is due to a poison accompanying the egg. Into this controversy it is not necessary to enter here: sufficient to say that the insertion of the egg is

followed immediately by the production of a mass of cellular tissue around it, which serves for the entire sustenance of the Gall-fly's larvæ without the more valuable leaf-substance being affected. It might even be said that the plant having learned that it must support these parasites has invented the gall as the least objectionable means of paying black-mail! The galls of the oak are well known, or some of them, for there are many. That known as the oak-apple, the leather-skinned, spongy mass at the ends of shoots, has a most interesting history which can be told here only in merest outline. There are oak-apples on both branches and roots, and they—as well as the Insects that proceed from each—are so unlike that until recently they were considered as distinct, that of the branches credited to *Dryoteras terminalis* and that of the roots to *Biorrhiza aptera*. They are known now to be alternate generations of one species. Briefly, this is the story: in the winter a wingless, Ant-like female breaks out of a root-gall—there are no males of this generation—and climbs the trunk and branches till she reaches the final leaf-bud of a shoot, and between the scales of the bud she pushes her ovipositor and lays about thirty pear-shaped eggs. When spring activity causes the other buds to unfold into leaves and a lengthened shoot, this expands into a big, roundish spongy mass; and if this is cut open it will be seen to contain as many cells as there were eggs, because the vegetable matter has completely surrounded the eggs without crushing them. Little white maggots hatch from the eggs, and feed upon the juicy sponge. There is far more than enough for them, and they are so well fed that before midsummer they have had enough, changed at first into pupæ, and then into fully winged Insects of both sexes, which bore their

way through the skin of the gall and fly around. These Gall-flies—more correctly Gall-wasps, for they are four-winged—pair, and the females instead of laying a batch of eggs in a leaf-bud, make their way to the base of the tree. Here they contrive to get into the soil until they reach an oak rootlet, in which they insert their eggs singly. Each gives rise to a single-chambered gall, but several galls in their expansion are forced into one mass. From these galls in winter the wingless females emerge, and so a cycle is completed.

The hard, spherical Marble-gall is produced for the lodging of a single grub of *Cynips kollari*—though it is frequently used by other hymenopterous Insects which are referred to generally as Inquilines. Though commonly the galls appear at some distance apart they are often found crowded to such an extent that two or three in expanding will run into each other. The small winged Insects break out in the spring following the summer in which the gall was produced. Among other oak galls, there are the Spangle-gall and Button-gall (*Neuroterus*), the Artichoke-gall (*Aphilothrix fecundatrix*) and the Bristle-gall (*Andricus lucidus*). Then on the wild rose there are the Robin's Pin-cushions, produced after the attack of *Rhodites rosæ* and containing many grubs in separate cells. Conspicuous on the leaves of the rose are the small galls of an allied species (*Rhodites nervosus*) about the size of a pea but running into half a dozen spikes. All these Insects are so small, that detailed descriptions sufficient for their identification would require many pages. A simple plan by which to know the Insects that caused the respective galls to be formed is to gather the galls and keep each kind in a separate glass-topped tin-box, and wait for the emergence of the perfect Insect.



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HORNTAILS AND SAWFLIES.

- 1 *Sirex gigas*. 2 *Sirex noctilio*. 3 *Cimbex femorata*.
 4 Larvæ of Alder Sawfly. 5 Hawthorn Sawflies and
 cocoon.



To face page 193.

ICHNEUMONS AND WASPS.

- 1 *Rhyssa persuasoria*. 2 Ruby-tail Wasp. 3 *Trypoxylon*
figulus. 4 Beginning of Wasp-nest. 5 *Microgaster*
glomeratus and its cocoon.

We must now glance at another very numerous family, the Ichneumon Wasps (Ichneumonidæ), of which we have more than twelve hundred British species: so that a few samples are all that can be given. They are parasitic on other Insects, the eggs being laid as a rule under the skin of the victim, and the Ichneumon's legless grub feeding on the blood and non-vital internal parts of the caterpillar or other host. Of the larger kinds a good example offers in *Ophion luteum*, a straw-coloured Insect an inch long, with antennæ of almost equal length. The curved hind-body starts as a long slender waist, then gradually expands almost to the hinder end, but is thicker from back to front than from side to side. This species victimises the caterpillar of the Puss-moth. In collecting Puss caterpillars for rearing one may often notice a little brown spot on the skin; and unless one wishes to breed out the Puss-ichneumon there is no use taking such a caterpillar. For the mark denotes where the Ichneumon's ovipositor has pierced the skin in inserting her single egg. By the time the Puss caterpillar has made its cocoon for pupation, the Ichneumon grub has come to a similar stage in development: it finishes off the caterpillar and constructs its own cocoon, and lies there as a pupa until the following summer.

Another imposing-looking Ichneumon—our largest native example—is *Rhyssa persuasoria*, but it is so exclusive a specialist that it must be sought only where the Great Horntail (*Sirex gigas*) attacks the pine trees, for *Rhyssa's* great object in life is to reduce the number of these timber destroyers. *Rhyssa* is a yellow-banded, blackish Insect whose head and body measure only an inch and a quarter in length, but it appears much greater because it possesses an ovipositor an inch and a half long, so

that its total length is two and three-quarter inches. This ovipositor, with its two guards, is only as thick as a bristle, and yet it is thrust through thick bark and solid wood, and through it an egg is passed into the tunnel of the *Sirex*. How the Ichneumon is able to locate this hidden boring is a mystery, but it does so; and the legless grub that results from the egg easily finds the *Sirex* grub and consumes it. That task finished the *Rhyssa* grub turns into a chrysalis; and when ultimately it assumes the winged state it has to bite its way through wood and bark to the outer world. As an indication that the *Rhyssa's* exceedingly long ovipositor is a special adaptation to need in bringing about the ruin of the Horntail's grub, we have only to look at a nearly related Insect—the *Pimpla rufata*—of similar form—entirely black, except the reddish legs—in which the ovipositor is only one-fourth of the length of head and body. This difference is explained by the fact that in laying its egg it settles directly upon its victim and needs but a short instrument for placing a single egg in the body. It is specially destructive to the caterpillars of the Large White Butterfly.

But many of the Ichneumons do not belong to the family Ichneumonidæ, but to the families Braconidæ, Chalcididæ and Proctotrypidæ, mostly quite minute creatures. One of these is very familiar in connection with the Small White Butterfly. The caterpillar is so large in proportion to the female Braconid in question (*Microgaster glomeratus*) that she appears to realise that one or two of her grubs would be unequal to the task of destroying the monster; so she injects fifty or so eggs in her victim, and the poor caterpillar has to feed, feed, feed, in order to satisfy this horde of uninvited guests. One may see these afflicted

caterpillars leave their food and climb up a wall or paling with the intention of turning to a chrysalis, but instead the host of parasites breaks through the skin and spin little cocoons of silk all around it, and what is left of the caterpillar dies. From each of the cocoons in due course issues a little black Ichneumon to carry on the work by laying eggs in other caterpillars. In many cases the caterpillar is permitted to change into a chrysalis, and the Ichneumon larvæ do the same; but instead of a beautiful Butterfly issuing from that chrysalis, scores or hundreds of the minute Ichneumons emerge. A breeder of Butterflies had the curiosity to count the number of Microgasters that issued from a single chrysalis of the Large White Butterfly, and found he had over one thousand two hundred of them! A battalion of Lilliputians to destroy one giant. Another of the same genus, *Microgaster alvearius*, pile their cocoons in a very neat manner under the body of their victim, as may be seen frequently under the caterpillar of the Gooseberry Moth (*Abraxas grossulariata*), a little extra pile marking the space between the two hinder pair of claspers. Occasionally we may find a number of Proctotrypid chrysalids standing on their tails on the remains of a Beetle larva from which the full-grown grubs emerged.

The family Chrysididæ consists of the Ruby-wasps or Fire-tails of which we have about twenty British examples. They are among the most brilliant of Insects, although all small. A very common species, *Chrysis ignita*, may be seen in summer sitting upon walls and woodwork, the hot sunshine making it blaze with metallic lustre of blue, green, red and gold. The integument is hard and glossy, the blue and green head and fore-body so strongly pitted as to present quite a rough

surface; the hind-body, which appears perfectly smooth, is also closely punctured, but so finely that it is evident only when examined through a lens. The family forms the series Hymenoptera Tubulifera, so named because the hind-body of the female ends in a telescopic tube through which the ovipositor is extruded. The active running to and fro of the female on the wall, and the vibration of her sharply elbowed antennæ are not due to mere excitement: she is hunting for the nest of a Mason-wasp (*Odynerus parietum*). Having located it she waits about until the cell has been filled with little caterpillars that are intended to serve for the sustenance of the grub that will issue from the egg she lays among them. Watching her opportunity, just before the Mason-wasp seals up the cell, the Ruby-wasp drops in an egg of her own. When this hatches the Ruby-wasp grub at once eats the egg of the Mason-wasp, and then has the store of caterpillars to feast upon. Owing to these nefarious practices the Ruby-wasps avoid any necessity for making nests of their own.

In the third series of Hymenoptera, known as Hymenoptera Aculeata, all the females are provided with stings which, when not in use, are withdrawn into the end of the hind-body. For the purpose of its lodging the three hindmost segments of the body are turned in, so that counting the visible segments they appear very few. With the exception of the Ants, the males have usually thirteen joints and the females twelve joints to their antennæ. The series is divided into four groups of families: the Bees (*Anthophila*), the Wasps (*Diploptera*), the Solitary Wasps (*Fossores*) and the Ants (*Heterogyna*).

The Bees (*Anthophila*) are more or less hairy Insects—so are many other Hymenoptera, but the

Bees are distinguished by the fact that *some* of their hairs are plumose, that is branched feather-fashion. This is a character to be appreciated only with the aid of a microscope, but the microscopist who finds any of these hairs on any hymenopterous Insect he is examining may set it down with certainty as some species of Bee. Then also some parts of the mouth are developed to form a proboscis, often called the Bee's tongue, but erroneously. The Bees live entirely on vegetable products—the nectar and pollen of flowers, the latter gathered on the hairy bodies and this often kneaded with nectar to form bee-bread for the food of their larvæ. Those of solitary habit make burrows in banks, in the dead stems of plants, or in decaying wood, and in these tunnels construct cells which they provision with bee-bread or honey (elaborated from the nectar), and on it lay an egg. The larvæ are legless. In the case of the Social Bees—those that form family communities—many of the females are barren and known as Workers. The Bee families have been arranged further into smaller groups: those with short, blunt “tongues,” those with short, sharp “tongues,” and those with long “tongues”; those that carry pollen on their legs, those that carry it on the under side of the body, and so forth. We need not here observe all these niceties of classification. Although several of the Solitary Bees are as large as the Honey Bee—and several so like it in general that they may be passed as such—the majority are much smaller and many very small, in the latter case as a rule to enable their bodies to pass up the excavated stems of bramble, etc, in which they make their cells.

The first family, the Archiapidæ, embraces the genera *Prosopis* and *Sphecodes*; and of *Prosopis* we have ten native species—small, with smooth

bodies and legs, and short, blunt "tongues." Their smoothness led in the past to their being strongly suspected of parasitism; it is now known, however, that some of the species make nests of their own, some in bramble-stems, some in the earth, others in mortar of walls, and that they line the walls with a silky, waterproof material of their own secretion. As nest-making Bees furnish their cells with a mixture of pollen and honey for the nourishment of their young, the absence of pollen-carrying hairs was thought to prevent their making such provision. But it is known that some at least swallow both pollen and nectar, regurgitating the rather fluid mixture into their cells. *Prosopis signata* may be described as a black Insect, about a third of an inch long; but the black is slightly relieved by two whitish wedge-shaped marks on the face, a white line along the front border of the fore-body and a little grey down on the legs. *P. communis* has the fore-parts black and the hind-body dark red, with three wedges on the face. In the genus *Sphecodes*, which are distinguished by their red or red and black hind-bodies, there are faint indications of the legs being adapted for pollen-carrying; but this appears to be a mere survival of a period when these Bees were industrious and gathered food for their offspring. In the present day there is too much evidence that they lay their eggs in the already provisioned cells of species of *Andrena* and *Halictus*, their not-distant relatives. *Colletes*, of which we have six species, are more hairy, and approach in appearance to the Honey Bee. They dig burrows in sandy banks, and form their cells by coating the burrow with several coats of a secretion from the mouth, which dries at once into a close resemblance to goldbeater's skin, but of much more delicate texture; and furnish the

cells with pollen and honey kneaded together to form a paste, upon which the larva feeds. A common member of this genus is *Colletes daviesiana* which may often be seen gathering pollen from flowers, especially those of the tansy.

Of the great genus *Andrena* we have no fewer than sixty British species, several of them such as *A. lapponica*, *A. trimmerana* and *A. hattorfiana* very like Honey Bees. They have hairy forebodies, but the polished hind-bodies are, as a rule, only slightly downy. *A. fulva*, however, has the hind-body heavily coated with deep orange hairs. These Bees are burrowers in sandy ground, and their operations in spring may be easily watched—at first our attention may be directed to the beginnings of their activity by the appearance on lawn or garden path of fairy mole-heaps. These are the earth stoppings of last year's burrows pushed up by the new Bees emerging from the cells. The first to appear are usually males, and these are little in evidence after the females have appeared and pairing has taken place. A few days later the females will be seen sinking new shafts, which go down vertically from five to ten inches, according to the species of *Andrena* engaged. Some species are quite solitary in their operations; others like company, and a considerable number of females of one species will sink their shafts side by side. As examples of the separatist habit we may mention *Andrena trimmerana*, *A. albicans* and *A. nitida*; whilst among the more neighbourly are *A. humilis* and *A. sericea*, of which hundreds of burrows may be found within the compass of a few square yards. These colonies may be due to a specially favourable patch of soil, or to a tendency such as is shown by many birds—to return to the spot where they were born for the purpose of laying their eggs. Some

of these colonies endure for many years: an old friend of the writer's—Mr V. R. Perkins—discovered such a colony of *A. humilis* at Wotton-under-Edge in the year 1876, apparently the only one in the neighbourhood, and found it in full activity in subsequent years. Mr R. C. L. Perkins reports it as still existing in 1914, and presumably it is still there, as it may have been for centuries.

Having sunk the shaft to the requisite depth the female *Andrena*—for all the work of the Bees is done by the females—digs out a rounded chamber at one side, and flies back and forth between the burrow and certain flowers that she favours, until she has accumulated a little heap of pollen sufficient in her judgment to nurture a single grub. The pollen she kneads up with honey, and then lays an egg on it; afterwards closing the mouth of the burrow with earth. Thus the grub leads an uneventful life in the darkness underground; there undergoes its transformation to a pupa, and in due course throws off the pupa skin and expands its wings, legs and antennæ, and finds its way by the shaft to the air after breaking through the earth stopper at its mouth. The rules of procedure for it must have been wrapped up in the egg, for the solitary Insect has had no communication with its parent, or the opportunity for watching other Insects under like conditions. In some species of *Andrena* there are two broods in the year; in others only one brood.

In their gatherings of nectar and pollen, some species of *Andrena* show special or even exclusive preferences for certain species of flowers. *A. albicans*, a common species, crowds upon the flower-heads of dandelion in spring; *A. bimaculata* in some places swarms on those of ragwort; *A. florea* shows marked preference for bryony, and *A. hattorfiana* for scabious. Hawkweeds attract *A. humilis* and

A. fulvago, but *A. cingulata* prefers speedwell. It is when the Bees are engaged in this work that the collector has the best chance for obtaining specimens. If an *Andrena*, for experiment, be caught in the hand, it will be noticed that it gives off a characteristic odour; in most species with a suggestion of garlic. *Andrenas* suffer much from the attacks of parasites, of which the most serious are those of other Bees of the genus *Nomada*.

The Bees of the genus *Halictus* are very similar to *Andrena*, but on the whole smaller—some of them are indeed regarded as the smallest of our Bees. Like *Andrena* they are miners, burrowing in banks where they form large colonies. Not only do they exhibit this desire to have their burrows in close proximity, but it has been ascertained that in at least some of the species a number of females will combine in the work of excavating a common burrow, with enlarged passing places, and at the bottom a communal hall in which each worker has room to build a separate pile of cells. The cells are oval, and are lined with a waterproof varnish provided by the Bee's salivary glands. Below the cell-chamber the burrow is continued downwards to a little distance, apparently as a drainage precaution. *Halictus morio*, one of the commonest species, is only about a fifth of an inch in length; but *H. cylindricus* and *H. albipes* are twice that measurement.

Dasypoda hirtipes is much like an *Andrena*, but is notable from the fact that its front and hind pairs of legs are very heavily haired. It constructs burrows from a foot to two feet in length, excavating with its jaws and using its front legs as brushes for passing the dug material under its body, then pushing it backward out of the burrow, afterwards distributing it widely. Leading off from the

burrow, she digs from three to six cells, provisioning them liberally with pollen. In this work her shaggy hind-legs are a great help, for on them she piles up pollen equal to half her own weight. When the larva has consumed all its store, it remains in its cell until the following summer before changing to a pupa.

In the family Denudatæ, the Bees of the five British genera are all parasites: they have no apparatus for carrying pollen, and they dig no burrows for they make no nests. They have learnt an easier if less moral method of securing the comfort of their progeny. When a cell of one of the more industrious and virtuous Bees has been provisioned, they obtain entrance and lay their own egg in it, and the larva eats up not only the store of food but the larva for which it was provided. The genera are *Stelis*, *Epeolus*, *Nomada*, *Melecta* and *Cœlioxys*. *Stelis minuta* is parasitic in the cells of *Osmia*; *Epeolus productus* serves *Colletes* in similar fashion, and *Melecta* upsets the nursery arrangements of *Anthophora*. The large genus *Nomada*, of which we have about thirty British species, live entirely at the expense of other Bees, mainly of the genus *Andrena*. They are neat little Insects, with a distinct waist and the bold, polished hind-body striped wasp-fashion with alternate bands of black or brown and yellow. The general public classes them as young Wasps. There is little doubt that as they are much exposed when watching on flowers and at the mouth of burrows for their victims, this warning livery is very useful to them. At night, Perkins says, "some of them sleep clinging by the mandibles alone to the heads of flowering grasses, the legs all drawn close to the body and the antennæ porrect, so as to resemble a little stalk. The bright colours of the body being much toned

down by the super-incumbent wings, the Bees closely resemble the seeds or flowers of grasses and are often difficult to detect." They all have a strong and mostly unpleasant odour. The following list of parasitic *Nomadas* and their *Andrena* victims will be useful; initial N. standing for the parasite and A. for the host :

N. alternata on *A. spinigera*; *N. argentula* on *A. marginata*; *N. armata* on *A. hattorfiana*; *N. bifida* on *A. albicans*; *N. bucephalæ* on *A. bucephala*; *N. conjungens* on *A. proxima*; *N. fabriciana* on *A. angustior*, *A. gwynana* and *A. nigroænea*; *N. ferruginata* on *A. humilis*; *N. flava* on *A. trimmerana*; *N. flavoguttata* on *A. falsica*, *A. minutula*, *A. parvula*, *A. saundersiella* and *A. subopaca*; *N. fucata* on *A. flavipes*; *N. goodeniana* on *A. nigroænea*, *A. nitida* and *A. thoracica*; *N. guttulata* on *A. cingulata*; *N. jacobaeæ* on *A. flavipes*; *N. lathburiana* on *A. cineraria* and *A. vaga*; *N. leucophthalma* on *A. apicata* and *A. clarkella*; *N. lineola* on *A. bimaculata*, *A. carbonaria* and *A. tibialis*; *N. marshamella* on *A. spinigera* and *A. trimmerana*; *N. obscura* on *A. ruficrus*; *N. obtusifrons* on *A. coitana*; *N. ruficornis* on *A. fucata*, *A. fulva*, *A. lapponica* and *A. varians*; *N. rufipes* on *A. denticulata* and *A. fuscipes*; *N. signata* on *A. fulva*; *N. tormentillæ* on *A. tarsata*; and *N. xanthosticta* on *A. præcox*.

In the genus *Melecta* we have only two British Bees—*M. armata* and *M. luctuosa*. These are comparatively large Bees, with broad hind-bodies. They are parasitic on species of *Anthophora*. *Melecta armata* is half an inch long, and black; but the black is toned down on the head and fore-body by a coat of grey hairs, and made to appear blacker on the hind-body by tufts of white hair at

the sides. The black legs are also varied by white hairs. There are two spines at the rear of the fore-body, but these are not easily seen, owing to the covering of hair.

In the family Scopulipedæ we have a group of four genera—*Ceratina*, *Anthophora*, *Eucera* and *Saropoda*—of solitary, industrious, long-tongued Bees. *Ceratina cyanea* is our only member of its genus, a little Bee that searches for the broken end of a dead bramble stem, which she mines and fills with cells, utilising some of the excavated pith to make partitions between the cells. *Anthophora*, of which there are four species, including three miners in the ground and a burrower into stems. *A. retusa*, a black, hairy Bee with well-developed pollen baskets, constructs earthen pots for her eggs and young. These pots, which are built underground, are filled with honey, and an egg laid floating on the surface. The larvæ of the Oil-beetle (*Meloë*) wait about on flowers visited by the *Anthophora*, and by clinging to her hairy body get conveyed to the nest, where they eat the Bee's eggs and afterwards revel on the honey, which is sufficient to see them through their development. Another Beetle (*Sitaris*) acts in much the same manner, but it is rare in this country. *Eucera longicornis* is covered with pale golden hairs, plentifully on the fore-body, sparingly on the hind-body. The male may be known at sight from all other British Bees by the length of his thick, black antennæ, at least equal to the half-inch of his head and body. The female sinks a shaft to a depth of six inches or more, with an oval cell at the bottom, which she coats with waterproof solution before filling it with the mixture of pollen and honey on which her egg is laid. Where this Bee is found burrowing, a number of her sisters may often be

found sinking their shafts in the immediate neighbourhood.

The *Dasygastræ* is another small family, consisting of the four genera *Heriades*, *Anthidium*, *Osmia* and *Megachile*, with the lower surface of the hind-body densely hairy for pollen-carrying. *Heriades florissomne* has a long narrow body suited for the female's occupation of boring into wooden posts to provide cells for her eggs. The males are fond of haunting flowers, and in the evening may be found asleep in bell-shaped flowers, such as those of the *Campanulas* which offer protection against the weather. They will be found rolled up Woodlouse-fashion. Capturing one of these males, we may ascertain "how it is done." Near the base of the hind-body on the under side there is a singular projecting stud, and the hind-body ends in a pair of short stout "horns." When the Bee rolls himself up for sleep these horns are fitted on the stud and serve to keep the hind-body rolled up. *Anthidium manicatum*—Gilbert White's "Carder Bee"—presents the unusual phenomenon of the male being larger than the female—his length exceeding hers by a fifth of an inch. The Carder Bee is more of an upholsterer than an excavator. Tunnels of some sort are a necessity for her nest-making, but she does not believe in boring them herself. Looking around she may find one that was made by a wood-boring larva of some sort, and having surveyed it and found it eligible, she seeks out plants that have downy stems or leaves, such as campion and mullein. These produce cottony hairs which are shaved off by the Bee, who gradually accumulates a ball of it almost as large as herself. Holding this between her legs she flies to the selected burrow, which is then carefully lined with the cotton. It is plastered neatly with cement from

her mouth to prevent it soaking up honey from the food mass she prepares as she divides the burrow into cells with cotton partitions.

We have ten species of *Osmia*, small hairy Bees which mostly follow the example of *Anthidium* by seeking ready-made chambers. *Osmia leucomelana*, however, bores out dead bramble-stems for the purpose, using the excavated pith in the construction of cells. *Osmia rufa*, which might be regarded as a small Honey-bee of florid complexion, but for its longer antennæ, has a great fondness for disused keyholes, old locks, overflow pipes and similar refuges. *Osmia inermis* looks for nail-holes in walls and posts, but sometimes nests under stones; and the two species *O. bicolor* and *O. aurulenta* frequently, and *O. rufa* and *O. spinulosa* occasionally, content themselves with empty snail-shells. *Osmia papaveris* sinks shafts in the paths of cornfields and lines her cells with poppy petals. But the great artists in this family are the more robust Leaf-cutter or Upholsterer Bees of the genus *Megachile*. One of them, *M. argentata*, makes burrows in the ground, and lines them with cut leaves; but the most familiar species is *M. centuncularis*, who may be seen at work in any garden where there are rose-bushes. These pieces are cut as cleanly as with a pair of scissors, and they are of various forms according to the purpose they are to serve: those for the sides of the cells being oval, those for partitions circular. First of all the Leaf-cutter secures an option on some decaying post, or the worn-out woodwork of a door-frame or window, and eating into this bores a vertical tunnel a foot or more deep. At the bottom a cell is made of the leaf-cuttings, arranged so that their edges overlap. The number of layers to a cell-wall varies, probably according to the wetness or dryness of the wood.

A number of layers are used for the partitions between cells; but a cell has to be provisioned with the honey-pollen mixture and an egg laid on it before it is capped and other cells built above it. Several shafts may be made side by side by the same Bee. Willughby's Leaf-cutter (*M. willughbiella*) usually selects a decayed willow-trunk for her operations, lining her tunnels sometimes with rose-leaves, sometimes sallow, or if near a garden with laburnum.

The family Socialæ includes the Bumble-bees (*Bombus*), the Cuckoo-bees (*Psithyrus*) and the Honey-bee (*Apis*)—Bees that live in communities. Respecting the last named, although *Apis mellifica* exists in the wild state in this country, nesting in hollow trees, in roofs and caves, it is chiefly a domesticated Insect, one of the remarkably few Insects that man has succeeded in bringing into subjection so that its labours can be exploited for his profit. Concerning the Honey-bee an extensive literature, ancient and modern, exists; and the species may be quite conveniently omitted from detailed mention here. In the Honey-bee as in the Ants we find the phenomenon of a colony continued year after year by successive generations without break; and so resembling human cities. But in the Bumble-bees, as in the Wasps, though the colony may consist of a great number of individuals, all will die before winter with the exception of a few fertilised young females, upon whose safe retirement during the cold season the sole chance of the race's continuance depends.

Of the genus *Bombus* we have seventeen native species, mostly giants among our Bees, with broad hairy bodies, powerful legs and wings, and long "tongues." Owing to the latter fact they are able to reach the nectar glands of tubular flowers inacces-

sible to the Honey-bee. For example, the Honey-bee fertilises the white clover because its tongue is long enough to reach the nectar-glands, which makes its visits worth while; but the red clover has too long a tube for the Honey-bee and it depends upon the Bumble-bees for the production of seeds. The Bumble-bees, however, are so clever that in the case of many long, tubular flowers they do not sacrifice the time necessary to push their heads into the opening of the flower, but bite a hole in the tube close to the nectar glands, which they suck without rendering service to the plant. Honey-bees and other Insects afterwards avail themselves of this short cut. The Bumble-bee colony, like the Beehive community, consists of three kinds of individuals: a large perfect female ("queen") capable of fertilisation, many imperfect females ("workers") and a few males ("drones"). The nests are made in an abandoned mouse-hole underground, under moss on the surface, or in a deserted bird's nest in a bush. The founder of the community is a fertile female who has survived the rigours of the winter in hibernation. In spring she selects a suitable site, and accumulates a mass of pollen which she moistens with honey and kneads into a solid paste. Upon this she constructs a cell wall of wax, lays about a dozen eggs within, and roofs them over with wax. The wax is secreted by the hind-body and exudes from between the rings on the upper side; it is brown in colour and softer than that of the Honey-bee. With more wax she constructs a tub within reach from the top of this cell, and fills it with honey. Then she sets to work actually to incubate her eggs, which takes four days; she meanwhile taking nourishment from the tub of honey. The young grubs find themselves on a heap of food, and each begins to hollow out a



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WASPS, BEES, ETC.

- 1 *Crabro cribraria*. 2 *Osmia rufa*. 3 *Vespa germanica*.
4 *Exetastes oscillatorius*. 5 *Pimpla rufator*. 6 *Vespa*
vulgaris. 7 *Nomada alternans*. 8 *Eucera longicornis*.
9 *Cerceris arenaria*.



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BEES.

- 1 *Bombus terrestris*. 2 *B. lapidarius*. 3 *B. venustus*.
4 *Andrena nigriceps*. 5 *Melecta armata*. 6 *Bombus*
hortorum. 7 *Prosopis signata*. 8 *Andrena fulva*. 9 *Apis*
mellifica.

depression for itself. As they grow larger the food disappears and the mother Bee knowing this makes a hole in the roof and drops in more bee-bread to each. Between her food-finding expeditions she sits on the cell-roof to maintain the temperature. When full-fed each grub weaves a fine silken cocoon and becomes a chrysalis; and in about three weeks from the laying of the eggs, they break through in the form of small, imperfect females (workers). In the meantime the mother has been making other heaps of bee-bread and waxen cells containing eggs; and the workers set to work collecting food for these and still newer broods. And so the community grows, with fresh batches of workers emerging from the cocoons every two or three days. At a later period the oldest workers lay virgin eggs from which drones are produced, and those of the mother now produce males and perfect females. An autumn brood of the latter are fertilised and go into hibernation in order that they may start new communities in the spring following. The empty cocoons are varnished and used for storing pollen and honey.

The underground communities of the common *Bombus terrestris*, our largest species, grow to considerable numbers during the summer, and may comprise seven or eight hundred individuals, but the more usual number would be three or four hundred; the other species form much smaller families, *B. muscorum* for example, at its zenith numbering only about one hundred and twenty. *B. terrestris* has the front of the black fore-body margined with yellow hairs, and the hind-body with four alternate bands of black and yellow. *Bombus lapidarius* is all black except the hinder segments of the hind-body which are clothed with orange hairs. *B. hortorum* is much like a small *B.*

terrestris, but the black fore-body is banded with yellow fore and aft, and the hind-body is yellow at its base and whitish at its tips with black between. *B. venustus* is of a general foxy red, paler on the hind-body beyond the base.

The remaining genus of the Socialæ is *Psithyrus*, consisting of several native species, the Cuckoo-bees, among them *P. vestalis* and *P. rupestris*. The first is a very good imitation of *Bombus terrestris*, and the second mimics *B. lapidarius*. It is difficult on a cursory glance to say which is the real Bumble-bee and which the Cuckoo; but there is an unfailing test for a closer inspection. The Bumble-bees have the broad hind-legs polished on the outside and fringed with stiff hairs, so constituting a basket in which they carry their big masses of pollen. The Cuckoo-bees are not industrious, there are no workers among them, and they have their legs evenly clothed with short hairs. They are, in fact, parasites upon the hard-working Bumble-bee, imposing their company upon the nest-makers, eating up their stores, and leaving their offspring to be fed and tended by their hosts. As a rule they appear to be received in a friendly spirit, but occasionally a mother Bee resents the intrusion and is sure to be killed.

The second division of the Aculeata is known as Diptoptera or Wasps, of which we have two families—the Eumenidæ or Solitary Wasps, and the Vespidæ or Social Wasps. Of the first family we have two genera, *Eumenes* and *Odynerus*. In these there is no community, but each female works on her own account without the assistance of workers. They are conspicuously coloured in black and yellow bands, and the hind-body proper is connected to the fore-body by a long tapering stalk—it is far too long to call a waist. We have

only one species of *Eumenes*—*E. coarctata*, which may be met with on heaths, where it constructs vase-like nests of clay and attaches them in most cases to the stems of heath or heather. The vases are hollow and provisioned with tiny caterpillars over which a single egg is suspended by a delicate thread from the top of the cavity. The idea appears to be to protect the egg and the newly hatched larva from being crushed by movements of the caterpillars. For a time the Wasp larva feeds upon the caterpillars from the suspended platform of the split egg-shell, until it has got large enough and firm enough to descend among its victims. Of the genus *Odynerus* we have about fifteen species, which usually adapt existing holes in the ground, walls and posts, in preference to excavating them for themselves, and storing them with caterpillars. One species, however, is a capable workman—the Mason Wasp (*Odynerus spinipes*), for it digs burrows in a bank and converts the excavated material into blocks of which she constructs a chimney-like erection above it to keep out intruders until she has provisioned her three or four branching cells with small green caterpillars—about thirty to each cell. This work completed and an egg laid in each cell, the towers are broken down and the material used for blocking up the burrow. A Ruby-tail (*Chrysis bidentata*) is usually on the watch for a chance for slipping in her own eggs before this closing takes place. A similar act of piracy is performed by the commoner species of Ruby-tail (*C. ignita*) upon the Wall Mason Wasp (*O. parietum*). Two other of our native species of *Odynerus*—*O. lævipes* and *O. melanocephalus*—mine into the stems of shrubs, such as brambles, whilst *O. trifasciatus* bores into old posts and palings.

The family Vespidæ consists of our eight species of Social Wasps, which includes the super-Wasp known by its distinctive name of the Hornet (*Vespa crabro*). Of these the Common Wasp (*V. vulgaris*) and the German Wasp (*V. germanica*) are the best known from the habit, when the serious part of their work is done, of flying into our houses in quest of jam and other delicacies; but the householder is not sufficiently interested to discriminate between species. A Wasp is a Wasp, and an awe-inspiring nuisance who might sting the baby to death if the Insect does not get hopelessly stuck in the jam-dish or drowned in the beer! Although these indoor visits constitute a distinct annoyance to the timorous, the earlier outdoor industry of the Wasps should entitle them to our consideration, for they are engaged chiefly in the destruction of caterpillars and other noxious Insects to serve as food for the multitude of Wasp grubs that fill cells of the many-tiered combs of their nests. These wonderful structures are underground in the cases of *V. vulgaris*, *V. germanica* and *V. rufa*; but *V. sylvestris* and *V. norvegica* build usually in bushes or trees. *V. austriaca* builds no nest of her own, but lays her eggs in the cells of others. The Hornet (*V. crabro*) builds in the hollow trunks of trees.

The nest is composed of an outer envelope consisting of superposed and connected layers of paper manufactured by the Wasps from thin shavings of woody fibres obtained from posts and palings, masticated and mixed with saliva: the resulting pulp being spread out by the mouth-parts. This envelope is enlarged from time to time as the increase of the colony necessitates more space. Within, at first a small comb of a few hexagonal cells—also made of paper—is made by the founder

of the Wasp city, a fertile female who went into hibernation in the previous autumn and is now impelled by the necessity for making provision for a family. An egg is laid in each cell, and when these hatch the grubs are fed by the mother Wasp catching Insects and supplying portions directly to the mouths of her offspring. When these attain the winged condition they are all workers—that is, imperfect females. These help in the feeding of grubs resulting from later batches of eggs, and build further combs for the mother Wasp to lay eggs in, and the original comb is enlarged by the provision of new cells all around its circumference. In this way the nest grows and grows, until in the autumn it may consist of nine or ten combs—each consisting, by the way, of a single layer of cells opening downwards—about eight inches in diameter. When it becomes evident from external conditions that it will be impossible to rear another brood before the time for hibernation, the grubs are taken out of the combs and killed, and the existing winged generation devotes itself to enjoying itself with the over-ripe plums and apples. The newly emerged females get fertilised and retire into some snug corner where they can pass the winter; the males and workers die. The abandoned nest for want of constant repair, rapidly falls to pieces. When the nest is in full working order the Wasps are greatly assisted in keeping it in a sanitary condition by the labours of larvæ of the Drone-flies (*Volucella*) which clean out the comb-cells and eat all refuse.

In the identification of the species there is so much general resemblance between them (except the Hornet) that a nice examination and comparison is necessary, especially as there are minor differences due to sex. The workers are smaller than

the males and the females larger. The chief distinctions will be found in the basal segment of the hind-body and the markings on the face. With regard to these latter, we find that three species—*V. vulgaris*, *V. norvegica* and *V. rufa* have a rude representation of an anchor surmounted by a coronet (both in black). The coronets are of different shapes in the several species. *V. germanica* has a triangle of three black dots instead of the anchor; in the worker the upper dot is enlarged into a more or less irregular upright bar. *V. sylvestris* has a single central black dot below the coronet, and in the female even this one dot may be absent. In *V. rufa* the distinctive mark is a reddish suffusion around the black marks of the base of the hind-body. The Hornet (*V. crabro*) is much larger than either of the others, and its markings are not so strongly contrasted, for the yellow is darker and the black is replaced by brown. The paper of the Hornet's nest is thicker, coarser, and of a browner tint than that of the other Wasps.

The division Fossores, consisting of the families Scoliidæ, Pompilidæ and Sphegidæ are all solitary in their habits, and consequently there are only males and females among them. The fore-wings do not fold along their length as in other divisions; and with the exception of one genus they all prey upon other Insects. The first family, Scoliidæ, is poorly represented in Britain, and the few species are considered to be rare; but probably their secluded habits accounts for the fact that they are not met with commonly. The so-called Hairy Ant (*Mutilla europæa*) is most Ant-like in the female, which is always without wings and much smaller than the male. They are parasites in the nests of Bumble-bees, the larvæ feeding internally on the Bee larvæ, and the females regaling themselves on

the stored honey. *M. rufipes* is smaller, with red legs. Other British Ant-like species are *Myrmosa melanocephala* and *Methoca ichneumonides*. The latter has been obtained from the cocoons of Moth pupæ, and it has been presumed that they were there as parasites. *Sapyga 5-punctata*, which has the hind-body marked with white, lives as a larva in the burrows of the Bee, *Osmia*, eating the egg and the provisions stored for the *Osmia* larva; but the female has been seen also carrying caterpillars. Our other species, *S. clavicornis*, has clubbed antennæ.

The family Pompilidæ, also poorly represented, are active runners as well as flyers. They exhibit a good deal of nervous excitement in their search for prey wherewith to store their burrows in banks, posts and stumps, chiefly selecting spiders for the purpose. Our native species of *Pompilus* include *P. rufipes*, *P. plumbeus*, *P. chalybeatus*, *P. niger* and *P. viaticus*. In some cases the Wasp prepares a burrow for the reception of the stung Spider; in other cases catches the spider first, then digs its grave close by unless it can find a hole ready made. Somewhat similar are the methods of *Calicurgus hyalinatus*, which, however, will often use an unoccupied Spider's hole for the reception of its victim and egg. *Agencia carbonaria*, another Spider-hunter, makes wide-mouthed earthen bottles for this purpose, hiding them in holes.

The last of the Wasp families—the Sphegidæ—includes the Sand-wasps (*Ammophila*) and about a dozen other genera. They all prey upon other Insects and upon Spiders. We have several species of *Ammophila*—long-bodied, black and red banded Insects that feverishly excavate vertical burrows in the ground to which they drag stung caterpillars.

Some of them on having to leave an incompletely furnished burrow take the precaution to cover it with a stone to keep out undesirable visitors. *A. hirsuta* specialises in quite large caterpillars of subterranean habit, and knows exactly where to dig for them; then stings where the effect will be to paralyse, not kill them. *A. sabulosa* may commonly be seen digging on heaths, sand-banks, etc. *Tachytes*, of which we have three species, have not so long a stalk to the hind-body. They are similar in their habits, but some of them victimise Grasshoppers instead of caterpillars. *Trypoxylon figulus* does not appear to be particular whether it constructs its clay cells in bramble-stems, in walls or in the earth. *Astata boops*, which burrows in the ground, provisions its cells with Field-bugs (*Pentatoma*), or one of our small native Cockroaches. *Gorytes mystaceus* drags the Frog-hopper nymph out of its protective covering of "cuckoo-spit" in order to use it for filling its cells, and *Mellinus* collects two-winged Flies for a like purpose. *Cerceris arenaria* specialises in Weevils, and *Pemphredon lugubris*, which nests in rotten beech stumps, collects such small fry as Black Aphides. Our thirty species of the genus *Crabro*, which look like miniature Social Wasps (*Vespa*), mostly burrow in dead stems or wood and prey on Flies.

The remaining division of the Hymenoptera Aculeata is the *Heterogyna* or Ants. As commonly known the Ants are wingless, but though the worker class are always so, the males and females when they emerge from their pupal cocoons are fully winged. After the "marriage flight," in which pairing takes place, the fertilised female sheds her wings voluntarily and sets about the founding of a new community. As in the Wasps, the Ants have a distinct "waist," consisting of the first joint

or the first and second joints of the hind-body reduced to very slender proportions. These joints or segments are so perfectly articulated that they permit of the freest movement in any direction, enabling the Ant to turn quickly or to double up its body in a way that might cause envy to the human acrobat or contortionist. Ants are scrupulously clean in all things, and constantly pay attention to their toilet. To this end each individual is provided with brushes and combs, which will be found at the end of the shank and top of the foot in the first pair of legs. The top of the foot-joint is slightly hollowed on its inner face, and the hollow is fringed with hairs. The bottom of the shank has a movable spur whose inner face bears close-set bristles and fits in the hollow of the foot. After any of the usual investigations in which the Ant has had to use its antennæ, these may be soiled—smeared, for example, with sticky honey-dew emanations from Plant-lice. Then the Ant may be seen to put her fore-legs in front of her face and draw her antennæ through this brush-and-comb combination. The head, body and legs are cleaned by passing one of the legs over them and sweeping off any particles of foreign matter that may be clinging to the scattered hairs; and then the leg so employed is cleaned by passing it between the brush and comb. The fore-legs in turn are cleaned by passing each through the brush and comb of the other side. No cat is more particular about her toilet than is the Ant.

The Ants'-nest is not a structure intended to last only for a season, like the nests of the Social Wasps, and then fall into ruin as the community which constructed and repaired it comes to an end. Theoretically, there is no reason why an Ants'-nest should not go on for ever. The life of the

individual is not bounded by a single season or year, as is the case with most Insects: they live for several years, and parents have the felicity not only of seeing their progeny but of feeding and training them also, so that the experience of one generation may be directly transmitted in this case to the next by example and precept. In the Ant community there are no leaders and no individual aggrandisement. Each one does what needs to be done as the occasion arises, the welfare of the community being the impelling motive. After her marriage-flight a female is capable of laying fertile eggs for the remainder of her life. She may return to the old nest—there are many females in a nest—or may lay the foundations of a new one.

In the latter case she may find a little hollow under a stone, that does not communicate with an existing nest, and is not within the area patrolled by other Ants, who might resent her invasion of their "sphere of influence." She lays only a few eggs at first, which soon hatch, and she attends to the helpless grubs, feeding them from her own mouth, and acting generally as a worker would do in an older nest. These first grubs develop into workers, that is females whose sexual development is imperfect. These set to work to excavate underground passages and galleries, and to obtain food for their mother, who henceforth devotes herself to the laying of eggs. The workers, in addition to providing suitable quarters for the eggs, and for the grubs when they hatch, carry them about to various parts of the nest with changing conditions of temperature and humidity. They feed the grubs with food from their own crops, keep them clean by licking them, and when they have spun the tiny cocoons (the so-called "Ants' eggs") in which they change to the chrysalis state, look after these

in the same way. They help the emerging Ant to get rid of the chrysalis skin.

A worker returning to the nest with a full crop after a food-seeking expedition meets a colleague, and they exchange greetings by movements of their antennæ in contact; then their mouths come together and food is given by the newly returned one to her sister. They will wash and brush each other, wrestle playfully, and carry home a slightly injured sister. If fatally injured or dead the victim is left; but when a death occurs in the nest the body is taken outside and cast upon the midden. Ants are not creatures of one idea. They are full of resource to meet extraordinary situations, and they have developed so many ways of getting a living that in the course of time they have branched off into several sub-families, many genera, and more than two thousand species, each with some specialty of structure or habit. So important have they become in the scheme of Nature that they have caused endless modification of plant-life, on the one hand to repel them from entering flowers and stealing nectar intended as a bribe for pollen-carrying Insects; on the other hand to encourage them to patrol the leafy regions and keep down destructive caterpillars and other nuisances. In the first case the plants have developed repellant hairs; in the other nectar-secreting glands have been provided by the plant for their refreshment, and in some exotic species hollow spaces in stems and roots have been provided to serve as nests. They have also set up alliances with various small creatures. Some like the Green-fly and the caterpillars of "Blue" Butterflies supply them with food; others like certain Beetles, Flies and crustaceans serve as domestic pets and sanitary helpers who live with them in their nests.

The Ants constitute the family Formicidæ, which is broken up into several sub-families, of which the first four contain all the British species. The first sub-family, the Camponotinæ, is represented here by the stingless genera *Formica* and *Lasius*. Our large Wood-ant (*Formica rufa*) is a well-known species, particularly obvious in pine-woods where we may behold long columns coming from or returning to the huge mounds of vegetable debris they have collected to cover their nest. These often reach a height of three feet, with a basal diameter of six feet. Their strong sense of orientation is made clear by the straightness of their tracks to distant oak trees to which they maintain constant traffic for honey-dew. The larvæ of the Rose-chafer and of *Clythra quadripunctata*, another Beetle, live in the nest. *Formicoxenus nitidulus*, an Ant of the sub-family Myrmicinæ, also lives in *F. rufa*'s nest. The somewhat similar *Formica sanguinea* has become rather notorious in the literature of Ant-life as our only species that is a slave-maker. It makes raids on the nests of *Formica fusca*, *F. cunicularia* and sometimes of *Lasius flavus*, killing or over-awing the adult Ants and carrying off the cocoons, that the emerging Ants may be impressed into their service as workers. *Lasius niger*, the Black Garden Ant, is one of the chief exploiters of the Aphis as purveyors of honey-dew. *Lasius fuliginosus*, the Shining Black Ant, lives chiefly in stumps and decayed wood, making galleries of a kind of cardboard it manufactures after the fashion of the Wasp.

We have only a single representative of the sub-family Dolichoderinæ, the rare and minute little carnivorous *Tapinoma erraticum*, whose rudimentary sting is not effective. Forel says it is in the habit of watching fights between rival species

of Ants, and carrying the dead off the field—to its own nest for consumption. The majority of our native Ants are found in the sub-family Myrmicinae in which the “waist” consists of two segments of the hind-body, developed vertically to form distinct scales or nodes. *Formicoxenus nitidulus*, already mentioned as sharing the nest of *Formica rufa*, belongs here. It is only about an eighth of an inch long, and the male, apparently, is always wingless. *Myrmica rubra* is one of our most plentiful Ants. Some authors split it into several species or sub-species under the names of *M. ruginodis*, *M. scabrinodis*, etc. In this section, too, occurs the minute reddish-yellow Ant (*Monomorium pharaonis*) that sometimes swarms in our houses and makes havoc of the housewife’s stores of sugar, fat, pastry, etc. It is only a twelfth of an inch in length, so it makes its way quite easily between floor-boards, under skirtings, or through any inconsidered crevice or crack, and in such numbers that it is difficult to deal with. The worst of it is that it is not a British Insect at all, but an enemy alien that came here nearly a hundred years ago, and spread from house to house. Apparently it cannot live out-of-doors with us; if it can it will not, finding all it needs in our household stores.

Of the sub-family Ponerinae we have only two species of *Ponera*, of which *P. contracta* is a small yellowish Ant, forming quite small communities under stones or among moss in the South of England only. The Ponerinae are noted for the possession of sharp stings.

FLIES

THE word Fly is one of the most hard-worked and misused of nouns. In its popular use it indicates nothing more exactly than an Insect that has the power to make use of the air for its journeys and occasions. Butterfly, Dragon-fly, Caddis-fly, Fire-fly, Mayfly, represent five distinct orders of Insects, all different from the Diptera, the order to which entomologists have tried to give the word special application.

As the word Diptera indicates, the true Flies never have more than two wings, though there is an indication that they have descended from Insects with four wings in the so-called "balancers" or halteres, consisting each of a minute globular or pear-shaped head on a slender stalk, that will be found just behind the wings. These are the merest vestiges whose presence does not vitiate the term Diptera; they are believed to be sense organs. The mouth-parts are not adapted for biting, but for sucking, and often form a proboscis as in *Bombylius*. The head, which is largely covered by the compound eyes, is connected to the fore-body by a thread-like neck which allows a considerable amount of rotation. The eyes have many facets which are sometimes separated by a fringe of hairs. Usually the eyes of the male are larger than those of the female. The antennæ vary so much in form that they are utilised in the classification of the species. In some they consist of numerous short, similar segments

connected to form a thread-like organ, as in most other Insects; or of one to three stout joints of which the last joint ends in a long bristle, which is frequently feathered, as in *Volucella bombylans*.

The wings, as a rule, are clear; in a few cases they are spotted or clouded with pigment. The system of nervures in the wings follows definite plans in the respective families. All the nervures and the intervening spaces (cells) have distinct names used in technical descriptions of species. If, for example, the wing of the Blow-fly be compared with that of the Bot-fly, the pattern of the nervuration will be seen to be quite distinct. The head of the newly formed fly in its pupa-case is provided with a bladder-like expansion in front, which later is withdrawn into the head. Its purpose is by inflation to force off the top of the pupa-case. This organ is not found, however, in those species that are not imprisoned in hard pupa-cases; but it occurs in about fifty per cent of the known species.

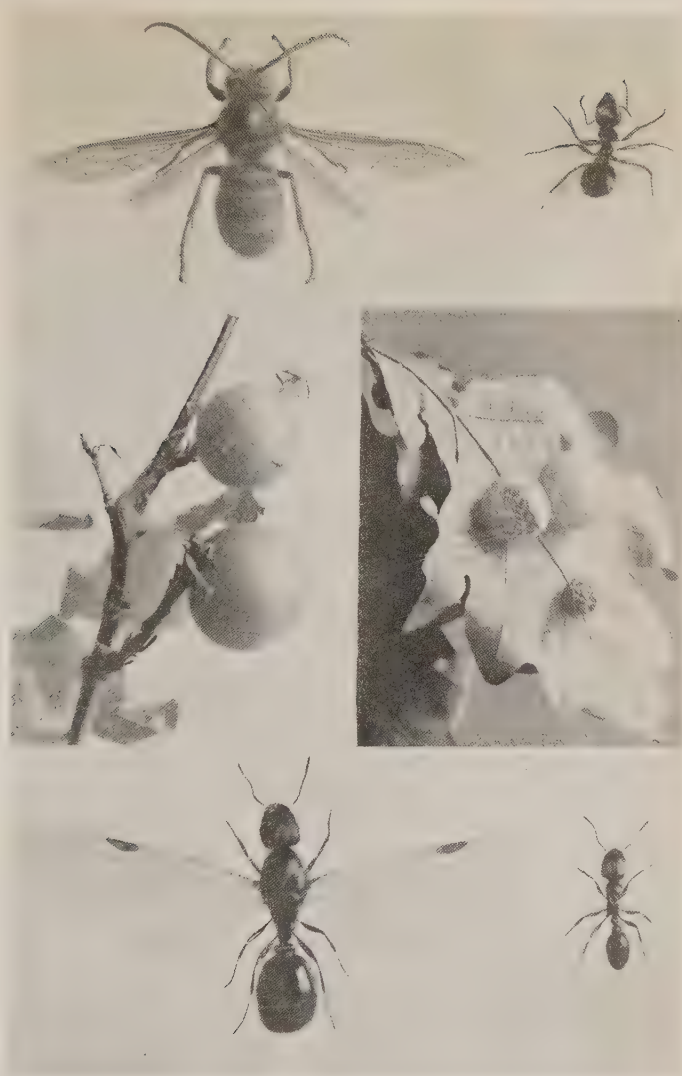
Metamorphosis is of a complete character in the Flies, the larvæ issuing from the egg as footless maggots in most cases, and often headless; then changing to a pupa in which the parts of the future Fly are visible as in the chrysalis of the Butterfly, or the larval skin may harden into a barrel-shaped case in which the change into a pupa is hidden. The first kind is a pupa obtecta; the second a pupa coarctata.

The food of the perfect Fly varies with the species: some suck the blood of vertebrate animals, some feed upon other Insects, some suck nectar from flowers and others prefer the juices of decaying matter, animal or vegetable.

The primary divisions of the Diptera are into three sub-orders: the Aphaniptera or Fleas, the Orthorrhapha and the Cyclorrhapha. The genera

in the two last are formed into four groups. The Fleas, being wingless, are often made to constitute a distinct order, but having regard for all the facts in their structure, modern authorities agree in regarding them as Flies which—probably following their adoption of parasitical habits—have lost their wing structures, which are represented by mere scales. In their larval state Fleas are worm-like, and feed upon any particles of animal refuse. They do not appear to remain long in this or the pupal stage, for Howard found that the cat and dog Flea took only a fortnight for its development. Although a hundred species of Flea are known, in this country only one of them, *Pulex irritans*, persistently attacks man. Dog or cat Fleas (*Pulex serraticeps*) may indulge in an experimental meal at his expense, but they prefer to return to their proper host. Many different animals have their special species of Flea, in most cases modified in structure to suit the particular conditions in which they live. Thus, various birds are afflicted by *Pulex avium*, the domestic fowl by *P. gallinæ*, the martin by *P. hirundinis*, the squirrel by *P. sciurorum*, the badger's own is *P. meles*, the hedgehog's *P. erinacei*; *P. gonioccephalus* affects the rabbit, the hare and their enemies the weasel and stoat, and *Hystrihopsylla talpæ*, which bleeds the mole and the field vole, is often found in underground nests of the Bumble-bees, due, no doubt, to these having been made in runs formerly tenanted by the mammals.

But there are other dipterous blood-suckers besides the Fleas. The females of many species of Gnats, Mosquitoes, and Midges are very fond of human blood, and some of them unfortunately do not have clean lancets but inoculate us with malaria and yellow fever. The Sand-flies (*Simulium*) have



To face page 224.

HYMENOPTERA.

- 1 Hornet. 2 Brown Ant enlarged. 3 Marble-gall of Oak.
- 4 Cherry-gall of Oak. 5, 6 Ant (Tetramorium), female and worker, enlarged.



To face page 225.

FLIES.

1. *Ogcodes gibbosus*. 2. Ox Gad-fly. 3. Dung-fly. 4. *Atherix marginata*. 5. Robber-fly. 6. Bee Drone-fly. 7. St. Mark's-fly, enlarged. 8. *Ceratopogon bipunctatus*, pupæ, enlarged. 9. *Spilographa* zoë, enlarged. 10. *Eristalis tenax*. 11. *Syrphus ribesii*. 12. *Helophilus pendulus*. 13. *Catambomba pyrastris*.

been suspected of spreading Pellagra in the same way. *Stomoxys calcitrans*, a species very like the House-fly (*Musca domestica*), indulges in this objectionable habit; and some persons cannot enjoy a country walk because they tempt the blood-appetite of *Hæmatopota pluvialis*. The Gad-flies (*Tabanus*) restrict their attentions more to cattle.

Passing in brief review the several groups of Diptera and their principal families, we have first the Nemocera, or Flies with thread-like antenna, whose first family is the Cecidomyidæ or Gall Midges, minute Flies of which about a thousand species are known to science, and of these three hundred and sixty species occur in Britain. The name has been made familiar to the public by occasional panic fears as to the destruction of our wheat crops by a species known as the Hessian-fly (*Mayetiola destructor*) which has caused considerable loss to farmers in the United States, where it is alleged that it was introduced from Europe in the baggage of the Hessian mercenaries employed by England in the War of Independence. The Cecidomyids are separated into nearly eighty genera. They are minute Insects with very few nervures in the wings; they differ a good deal in their life histories, many of the larvæ feeding in the stems of grasses, sedges, mosses, and fungi. Others feed in decaying wood and in galls made by other Insects; but a large number themselves cause the formation of galls in which they feed. A few species are internal parasites in Insects. The genera *Lestremiæ* and *Miastor* are remarkable for the asexual form of reproduction known as pædogenesis. The larva develops ovaries which produce eggs; these hatch into larvæ which remain within the parent larva and themselves produce eggs. The process may be continued for about

five generations, and then metamorphosis takes place and a winged, sexual generation appears.

Most of the species are attached to a particular species of plant for their food, and as some of them feed internally this sets up the formation of a gall. The Hessian-fly larva feeds in the lowest leaf-sheath of wheat or rye, and its attack on the stem causes the upper part of the plant to wither and to produce no "ear." It is about an eighth of an inch long and pale yellow. The pupa forms within the larva skin which becomes hard and red, very closely resembling a flax-seed. The larval attack is in June, and the Fly appears in September. It has a black fore-body and red hind-body, the segments of the latter each with a central oblong patch of black. Much damage has been done on the Continent by this Fly, but in this country the attacks have not been very serious or widespread. The variety of wheat known as "Sensation" appears to be specially open to bad attacks.

The family Mycetophilidæ or Fungus Midges is another large assemblage of thirty-four genera with one hundred and seventy-eight British species of minute Flies, some of them no larger than Fleas. The wing-structure shows a distinct advance upon Cecidomyidæ, the nervuration being much less simple. The larvæ are very elongated, transparent and worm-like, living mostly in decaying vegetable matter, many of them in fungi. They exude slime, like slugs, and construct cocoons for pupation, shedding the larva skin when becoming pupæ. Some of the exotic forms have become notorious in natural history literature on account of their larvæ migrating by millions in a vast ribbon composed of this slime. From this habit certain species of *Sciara* are known in parts of Europe as Army-worms; and in the United States another species of

the same genus is known as "Yellow-fever Fly," from a belief that they appear in vast numbers during an epidemic and a suspicion that they have something to do with the visitation. Some of the Fungus Midges may be found in great numbers crawling over heaps of decomposing garden rubbish, in which they are laying their eggs.

The Culicidæ consists of the Gnats and Mosquitoes. At the outset let it be stated clearly that the two names indicate one thing: all Gnats are Mosquitoes, and all Mosquitoes are Gnats. The idea that appears to dominate the minds of the people who insist that Mosquitoes are different from Gnats is that some bite and cause painful swellings; others do not. Those that do so are Mosquitoes; those that do not are Gnats! For their benefit let it be said that with rare exceptions the male passes us by as having no interest for him whatever, but that the female is out for blood and knows at what point of our anatomy it can be reached most easily. Plunging in her very prominent lancets she rapidly pumps up sufficient to gorge her hind-body. The mouth-parts of the male are not so efficient for this work. The sexes may be distinguished readily by reference to their long antennæ: in the female these have a few hairs arranged in circles at the base of the joints, but in the males these are so long and so numerous that the antennæ become dense plumes. In this family the Flies have minute scales on the wings, chiefly along the nervures. The larval stage is passed in water, where the Insect preys upon minute organisms, and breathes by means of a respiratory tube which it pushes through the surface film. Gnats have been got rid of in malarious districts by coating ponds with paraffin oil, but the same results might be less quickly attained by the introduction of duckweed (*Lemna*),

which effectually covers the surface and prevents the Gnat larvæ from breathing. Our common Gnat is *Culex pipiens*, but we have many other species, among them three of the genus *Anopheles* which have in recent years become important from the discovery that they are the carriers of the germ of the malaria parasite (*Plasmodium vivax*). Of these Malaria Gnats (or Mosquitoes) a very brief description must be given, as it is important that everyone should know them and destroy them. *A. plumbeus* is the smallest of the three and has darker wings due to the density of the scales upon them. The fore-body has grey markings, and the long jaw-feelers (palpi) on each side of the proboscis are banded. *A. bifurcatus* is larger, has unspotted wings, the fore-body has two broad bare lines in front, and there are golden hairs on the hind-body. *A. maculipennis* is distinguished by four spots in the middle of each wing. Anopheline Gnats may be known from Culicine Gnats by observing their attitudes when at rest: Culicines hold the body parallel with the surface upon which they are standing and usually raise the hind pair of legs, curving the foot-joints upwards; Anophelines rest with the head low and the hind-body at a distinct angle with the resting base, whilst the hind-legs are extended straight backwards. The larvæ of the common Gnat may be found in water that is almost fetid, but the Anophelines prefer clear, shallow, stagnant (or almost stagnant) water in which there are water-weeds, rushes, etc. *A. plumbeus* has been found almost solely in rot-holes in the trunks and roots of trees, mostly in or about woods.

The family Chironomidæ, of which we have about two hundred species, are also known popularly as Gnats and Midges. They are all small, some of them quite minute, with slender bodies, narrow

wings, long legs, the antennæ plummy in the male, but the proboscis is not extended forwards as in the true Gnats. Most of them pass their larval stage in water; but most of the Midges (*Ceratopogon*) may be found under loose bark on trees or at the roots of herbage among decaying vegetable matter. Some of them as adults are notorious blood-suckers, and annoying pests about sunset from their habit of alighting on the neck and temples unfelt until they have pierced the skin and set up burning irritation. *Ceratopogon varius*, *C. bipunctatus* and *C. pulicarius* are among the worst offenders in this respect. Here again it is the females that are the blood-suckers. The familiar "blood worms" of mud banks are the larvæ of *Chironomus*, the Harlequin Gnat.

The family Psychodidæ, of which we have nearly fifty species, are minute hairy-winged Insects that leisurely flit about vegetation and the ground and in windows in summer. The wings are very broad in proportion to their bodies, lance-shaped, the abundant hairs forming rather indefinite patterns. None of the British species is a blood-sucker; and they have no annoying habits. Most of the larvæ live in manure, but a few are aquatic.

The Tipulidæ, or Crane-flies, are from their superior size better known, particularly the "Daddy-long-legs," which has become familiar to all from its bungling habits and apparent ignorance as to what to do with its excessively long legs which are readily discarded. These are really for use in walking over grass, where the female (whose hind-body is pointed behind) lays her eggs in the earth; and from them hatch out the destructive dirty-grey larvæ known as "leather-jackets" which feed upon the grass roots, where they are hunted for by the rook with his pick-axe beak. The pupa, too, is a

very familiar object, owing to its habit of half-emerging erectly from the ground when the transformation to the winged state is about to take place. The two curved respiratory horns below the head give it a remarkable appearance. A larger, less common, form of "Daddy" (*Pedicia rivosa*) has the wings blotched with brown.

The family Bibionidæ, which has about forty British species, is made familiar through at least two species—the St Mark's-fly (*Bibio marci*) and the so-called Fever-fly (*Dilophus febrilis*) whose larva is so destructive to the roots of the hop. In many cases the sexes are coloured differently: the females red or yellow and the males black. St Mark's-fly, so called from its appearance about the date of St Mark's day (April 25th), is worth examining minutely, noting the difference in the heads of the male and female, the former broad and the latter long. Looked at from in front, the hairy compound eyes of the male will be found to meet, covering the head; whilst in the female they are far apart. Looked at from the side the male appears to have two pairs of eyes, but this is due to each eye being divided into a large upper portion and a small portion below. The purpose of this division is not known. The larvæ feed on grass roots.

The family Simuliidæ consists of the single genus *Simulium*, of which we have two species: the Sand-flies, whose larvæ are aquatic and construct curious slipper-shaped cases on stones in running water, preparatory to pupation. Dr Sambon a few years ago stated that the disease known as Pellagra is spread through the biting of the female of *S. reptans* introducing the germs into human blood.

The division Brachycera, or Short-horns, includes ten British families. Of the first of

these, Stratiomyidæ, a familiar example is the Chameleon-fly (*Stratiomys chamæleon*), whose wings appear small in proportion to the broad hind-body, which is black with three short yellow marginal streaks on each side. The larva is aquatic, long and strap-shaped, ending behind in a long respiratory tube and in a rosette of hairs which lie on the surface of the water.

The family Leptidæ is known by the popular name of Snipe-flies. One species (*Leptis scolopacea*) with mottled wings, and the thick, yellow hind-body spotted with black, is common in meadows. *Atherix ibis*, with clouded wings and the hind-body belted alternately with yellow and black, has a curious method of egg-laying. The females in hundreds cluster around the end of a branch overhanging water, and form a solid mass like Bees swarming. They deposit their eggs and die.

The family Tabanidæ consists of the Gad-flies and Cleggs, of which several are well known, one at least is painfully familiar to most ramblers in the country. This is the Clegg or Rain-fly (*Hæmatopota pluvialis*), the grey, dusty-looking Fly that you have no suspicion is sitting on your hand or neck until its sharp lancet is thrust into your flesh. To those persons who have the right quality of blood, this Fly is an intolerable persecutor whose attacks take away much of the pleasure to be derived from woodland walks. A near relation, the Gold-eye (*Chrysops cæcutiens*), has the same objectionable habits, but is very different in appearance, the wings being bordered with smoky brown along the front margin and a broad bar of the same across them from back to front. This Insect has beautiful glowing eyes of golden-green dotted with purple; and the black hind-body has a broken belt of yellow.

The much larger Gad-fly (*Tabanus bovinus*), with its grey and black markings, devotes its attention more to horses and cattle. In this family, as in the Gnats and Midges, it is only the females that exhibit this annoying thirst for blood. The family is represented by about twenty British species.

The family Bombyliidæ is represented in Britain by several species of *Bombylius*, stout-bodied hairy flies with a strong superficial resemblance to a small Bumble-bee. One of these, known as the Humble-bee-fly (*Bombylius major*), is about two-thirds of an inch long so far as head and body are concerned, but its proboscis, which is half that length, is held stiffly in front of it, so that its apparent length is nearly an inch. The body is thickly coated with long, brown, silky hairs, and the wings are clouded with brown along the front and base, and square spots of colour connect the nervures at many points. The Fly is not a blood-sucker, but uses its long proboscis solely for obtaining nectar from deep flowers, and it has wonderful power of hovering in front of flowers without the body moving. It is the Insect that fertilises the flowers of the Primrose. The larva lives as a parasite upon the grubs of the Bumble-bee, the tower-building Mason-bee (*Odynerus*) and a Mining-bee (*Andrena labialis*).

Of the family Acroceridæ we have but two British representatives—*Acrocera globulus* and *Ogcodes gibbosus*—and both are rare Insects. They are characterised by a very small head and inflated high fore-body, giving them a hump-backed appearance. The wings are relatively small for the bulky body they have to carry. *Acrocera* has a long slender proboscis, but in *Ogcodes* the mouth-parts are so atrophied that it is doubtful if they serve any useful



HUMBLE BEE
(*Bombus terrestris*)
and Marigolds

purpose. The fore-body of *Ogcodes* is covered with long whitish-grey hairs, and the hairy hind-body is belted with white and black. The larva is a parasite in Spiders and their egg-cocoons, and the perfect Fly in turn is specially preyed upon by a little Wood-wasp (*Crabro interruptus*) for provisioning its cells.

The Asilidæ or Robber-flies are represented by one of the largest of our native Flies, the Hornet-fly (*Asilus crabroniformis*), so called on account of its yellow-brown coloration and the broad band of black at the base of the hind-body; there is, however, no resemblance to a Hornet, the body being long and tapering, in the larger female, to a sharp point. The pale brown wings have a row of dark spots along the hind margin. The stout horny beak, partially hidden by a bunch of golden bristles above it, is used for impaling less powerful fliers which it runs down, and alighting on their backs plunges the stiletto into the fore-body. Insects that are themselves rapacious often have the tables turned upon them by the Hornet-fly, Wasps, Dragon-flies and Tiger-beetles being among the victims recorded. One observer watched a Hornet-fly kill eight Moths in twenty minutes. The larva is also predaceous, attacking the larvæ of Beetles, sometimes boring into them.

The Empidæ is another family of predaceous Flies, of which we have about two hundred British species. A very common species is *Empis tessellata*, which may be seen hawking along hedgerows, impaling other Insects and sucking their juices. It is a long, slender, hump-backed, hairy, black beast, with long bristly legs and pale brown wings. Its beak is relatively much longer than that of the Hornet-fly and carried downwards at right angles to the head.

The Pipunculidæ consists of small Flies with globular heads that are nearly all eyes, whether viewed from the front or side. They have, in fact, the distinction of possessing eyes that are, comparatively to the size of body, larger than those of any other Flies. They are black or brown in colour; and often occur in swarms about hedges. The larvæ appear to be internal parasites of other Insects.

The Conopidæ are slender Flies with a pointed prominence between the eyes supporting the clubbed antennæ. The thorax is globular, and the hind-body, slender at the base, increases backwards and the thick extremity is curved under. The long, slender proboscis is usually carried hidden between the legs. The species of *Conops* are rare. *C. quadrifasciatus* is got up in strong likeness to a *Crabro*, the yellow hind-body being belted with black. The female lays an egg among the hairs of a Bumble-bee or other Hymenopteron, and the larva on hatching bores into the body and lives there.

The Syrphidæ or Hover-flies is one of the largest of the Fly families, several thousand species being known, of which a large number are natives of Britain, and many of them are quite familiar Insects. In our gardens, when there are flowers and sunshine, some of them may always be seen, hovering on rapid wing and quickly darting aside on our approach. Some are Bee-like in form and known as Drone-flies (*Eristalis*); others from their colouring look like Wasps. Such resemblances earn for them a certain amount of respect, which is more than due to them for their great services. They are furnished with a thick fleshy proboscis, but it is not used aggressively, as in the winged state they are lovers of flowers and the nectar and pollen to be obtained therefrom. *Volucellæ*

bombylans is a hairy-bodied black and yellow Fly that might pass for a small Bumble-bee. As a fact it visits the nests of *Bombus*, and before its mission in life was understood it was accused of using its uniform for the purpose of imposing upon these Bees in order to infect the nests with parastical larvæ. But its larvæ are beneficent scavengers who spring-clean for the Bumble-bees and rid their nests of noxious refuse. Another species, the Pellucid Drone-fly (*Volucella pellucens*) renders similar service to the Wasp colony, cleaning out the cells of the combs after use by one generation of Wasp grubs and making them fit for egg-laying. The Wasps know their value, and though living on Insects do not molest either the Drone-flies or their blackish larvæ. Modern observers had noted the friendly attitude of Bumble-bees and Wasps to these Flies, and had tried unsuccessfully to feed the larvæ on hymenopterous grubs; but it was left for J. H. Fabre to show by his investigations in the nests of *Vespa germanica* what their real functions are. His account has been fully verified in detail by the present writer.

Eristalis tenax is perhaps the most familiar of these Drone-flies, for it is Bee-like and has the habit of coming into houses, and, should the weather be bad, staying for two or three days. It is a buzzer, but its note is quite different from that of the Bee. Still, it is generally accepted as a Bee and as such allowed to remain. Its larva is the remarkable rat-tailed maggot that lives in liquid filth, keeping up communication with the air by means of a long telescopic tube—the rats-tail.

The Hover-flies proper of the genus *Syrphus* are the ones most frequently seen in the garden, where their black and yellow banding makes them conspicuous. Happy the gardener whose flowers

attract them in swarms, for they help him to keep down the myriads of Plant-lice that for ever suck the juices of his rose-trees—valuable auxiliaries to the Lady-birds and their larvæ. The Hover-fly's larva is a soft pale green creature with a white line down the centre of its pear-shaped body, which is broadest behind. They feed entirely upon Plant-lice, seizing an Aphis and sucking it dry, then dropping the empty skin. The operation takes about a minute; and the Syrphus larva repeats it continuously day and night for about ten days, by which time it is full-fed and pupates. Of quite a different bearing to the needs of the gardener is the larva of the related *Merodon equestris*, whose mission in life is the destruction of narcissus bulbs by eating out their centres. A different habit again, more like that of *Volucella*, is that of *Microdon mutabilis*, whose disc-like larva lives in Ants'-nests where it acts as a scavenger. All the Syrphidæ are much attracted by the flowers of Michaelmas daisies, and later by those of the ivy where one may find the big black Noontide-fly (*Mesembrina meridiana*).

The family Anthomyidæ consists of many genera of Flies which are superficially much like the House-fly. One of the most notable of the British species is the Cabbage-fly (*Anthomyia brassicæ*), whose larvæ attack the roots and stems of the cabbage, causing the leaves to change colour and droop.

The Tachinidæ is an enormous assemblage of parasitical Flies that victimise chiefly the larvæ of Butterflies, Moths and Beetles. We have about two hundred British species, but few of them are at all familiar except to the Diptera specialist. One of the best known, because of its size and burly proportions, is the large, black Spiny-fly (*Tachina grossa*) whose fore-body is broader than the head,

and the almost circular hind-body broader still. The Insect is liberally clothed with strong black hairs and its legs are very spiny. Many lepidopterists have been disappointed in their hope of seeing a fine Butterfly or Moth emerge from a chrysalis, when this huge Fly broke out instead. *Tachina fera* is only half the size of the foregoing, less hairy, and its hind-body is dull yellow with a longitudinal black band.

The Dexidæ are in many respects similar to Tachinidæ, but have longer legs, and the antenna has the bristle downy. There are about twenty British species, whose larvæ are internal parasites, chiefly in Beetles and snails.

The Sarcophagidæ also are similar, but the bristle of the antenna is feathered at its base. Among the British species is the Flesh-fly (*Sarcophaga carnaria*), much like the Blow-fly, but chequered with black and grey on the hind-body and striped on the fore-body. It does not come into houses; and the female, who lays a prodigious number of eggs, retains them until they hatch, so that when deposited (chiefly on animal matter) the larvæ are ready to begin operations at once. *Cynomyia mortuorum*, of bright metallic blue coloration, is of similar habits to the Blow-fly.

In Muscidæ, which contains the too familiar House-fly, Blow-fly and Green-fly, the bristle of the antenna is feathered completely. All the larvæ feed upon dead animal or vegetable matter, selecting the moister portions of any mass. The House-fly (*Musca domestica*), also in recent years dubbed the Typhoid-fly because of its efficient agency in carrying the germs of that disorder, is bred in stable and domestic refuse. The Blow-fly or Blue-bottle (*Calliphora vomitoria*) lays its eggs in batches on dead animals, and on joints in the larder if

allowed access to them. The Green-bottle (*Lucilia cæsar*) is an outdoor Fly and has a marked preference for fish. The Stable-fly (*Cyrtoneura stabulans*), a dirty grey Insect between the House-fly and Blow-fly for size, frequently comes into houses; and so does *Homalomyia canicularis*, often called the Smaller House-fly. The House-fly which pricks bald heads with the pointed tongue that is carried straight in front of the head, is *Stomoxys calcitrans*, whose larva is also a dung-feeder. Then there is the somewhat similar Bacon-fly (*Polictes lardarius*), which lays its eggs on hams and bacon.

The *Æstridæ* or Bot-flies is a small family of large Flies of considerable economic importance, owing to the wholesale injury to the hides of living cattle inflicted by the larvæ. They are not biters or blood-suckers, the mouth as a rule being atrophied or imperfectly developed. The eggs are laid on the hairs of victims where they can be licked off easily, and so find their way inside; or the female retains them until hatched and then deposits them on the nostrils. They do not appear to feed upon the tissues but on the internal secretions of their hosts, but bore through tissues and skin to effect their escape. In so doing they set up considerable irritation and cause tumours to form. We have only about ten British species—but 'tis enough. Among these are the Horse Bot-fly (*Gastrophilus equi*), the Ox Bot-fly (*Hypoderma bovis*), the Sheep Bot-fly (*Æstrus ovis*), and the Deer Bot-fly (*Cephenomyia rufibarbis*).

The Hippoboscidæ consists of Flies that are not popularly regarded as such. They are all parasites upon vertebrate animals, and run more to legs than to wings, which are entirely absent in most cases. The female retains her eggs until they have not

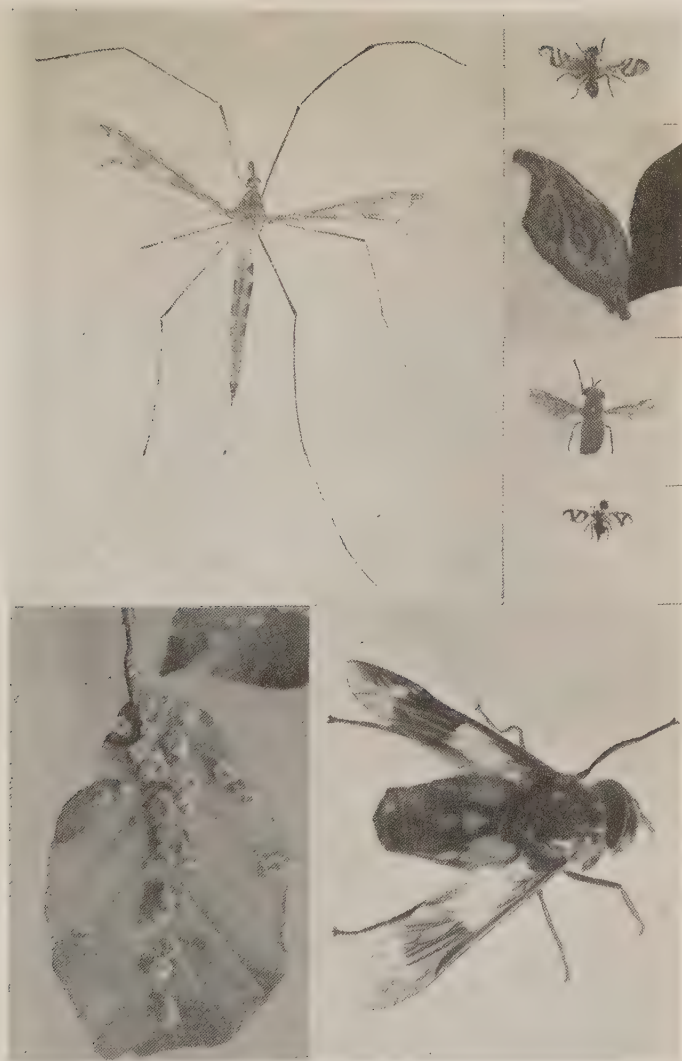
only hatched, but until the young have almost completed their development. The mouth-parts are in the form of a pair of flaps which fall apart to permit the protrusion of a sucking tube. The so-called Sheep-“tick” (*Melophagus ovinus*) is of this family. It is wingless, and its structure adapted for clinging to the skin of the sheep beneath the protecting fleece. Sheep-shearers, to whom it is a very familiar object, decline to accept it as a Fly. The Forest-fly (*Hippobosca equina*) which is so conspicuous a pest on the flanks of the New Forest ponies, is similar to the Sheep-tick, except that it has a serviceable pair of wings. The Deer-fly (*Lipoptena cervi*) when it emerges from the pupa has wings, but after pairing it settles down on the coat of the Red Deer and casts its wings, and so remains all through the winter. Several species of this family confine their attentions to birds, and these are all winged. *Stenopteryx hirundinis* is plentiful in the nests of the swallow.

The family Braulidæ has been constituted for the reception of a single species—*Braula cæca*, the so-called Bee-louse, which often is so plentiful in a hive as to render the Bees unprofitable owing to the irritation and unrest it sets up, diverting the Bees from their regular functions. It is much like the Sheep-“tick” superficially. The egg appears to be laid in the cell of the Bee, and the larva becomes a pupa almost immediately. In three weeks it is a perfect Insect and attaches itself to the fore-body of the Bee. It is supposed to be blind, but this is not so, though its eyes are very imperfect.

STONE-FLIES AND BIRD-LICE

ONE of the little known orders of Insect life is the *Platyptera* or broad-winged Insects; but the reader may be inclined on reaching the end of this chapter to regard the name as an example of scientific humour, for the greater part of the order, so far as Britain is concerned, consists of Insects entirely without wings, broad or narrow. With us it is a very small order; but it includes also the so-called White Ants (*Termitidæ*) of the tropics, which gives it greater importance. Our *Psocids* or Book-lice have considerable resemblance to the *Termites*.

The *Platyptera* is divided into three sections or sub-orders: *Perlaria*, *Psocidæ* and *Mallophaga*, which we will glance at in turn. The *Perlaria* consists of the single family *Perlidæ*, the members of which are popularly known—and this chiefly to the trout-fisher—as Stone-flies and Creepers. They have two pairs of netted, membranous wings, the fore and hind-wings being separated by an interval. They are longer than the body—this is really their breadth from which the name *Platyptera* is derived—and of some brownish tint. The fore-wings are longer and narrower than the hinder pair, and when the Stone-fly is at rest they are all laid flat and overlapping along the back, the broader hind-wings having to be folded fanwise for this purpose. Looking at the trunk of a Stone-fly we shall find that in place of the usual three divisions—head, fore-body and hind-body—we have here five sharply defined portions. In all Insects the fore-body



To face page 240.

FLIES.

- 1 *Pedicia rivosa*. 2 *Æcidia heraclei*. 3 Interior of gall of *Trypeta cardui*. 4 Stout or Clegg. 5 *Trypeta cardui*. 6 Galls of *Hartigiola* on beech. 7 *Chrysops cæcutiens*, enlarged.



To face page 241.

SPRING TAILS, ETC.

- 1 *Tomocerus plumbeus*. 2 *T. longicornis*. 3 *Anurida maritima*. 4 Eggs of Psocid. 5 Silver-fish. 6 *Achorutes ornatus*. 7 *Stenopteryx hirundinis*. 8 *Melophagus ovinus*. 9 *Atropos divinatoria*.
(All enlarged except 7 and 8.)

really consists of three parts, the prothorax, the mesothorax and the metathorax, and each of these segments bears one pair of legs; but in the majority of Insects this triple character is hidden on the upper surface by one section being more highly developed than the others. Here they are quite distinct both above and below, and it is this distinctness that takes the hind-wings away from the fore-wings, and the pairs of legs it will be seen are also apart. The head is broad, the antennæ are long and many jointed. The mouth is furnished with jaws, but these are feeble and have no value to the Stone-fly, which being short-lived like the May-fly does not appear to require food.

In their early life the Stone-flies are aquatic larvæ haunting the bottoms of streams and ponds, and are then much like the adult minus the wings. The larva becomes a nymph with its wing-buds on its back without any resting period, and continues actively chasing and eating the larvæ of Mayflies and similar prey until it feels the impulse to climb out of the water, split its skin and shake out its wings, much after the manner of the Dragon-fly. In their aquatic stages they extract air from the water through the skin or by means of gill-tufts, and probably for that reason prefer the well aerated tumbling water at the foot of falls. The perfect Insects are usually found near the water. Their flight is heavy and slow, and they are captured easily, as a touch brings them to the ground. There are about two dozen British species, mostly considered rare.

The Willow-fly (*Nemoura variegata*), a brownish Insect, little more than half an inch in length, with delicate wings that span an inch and a quarter, and very fine antennæ as long as the body, is one of the first of the British species

that is likely to be met with, as its nymph occurs in ponds as well as streams. All the other species appear to object to stagnant water and are found chiefly where it is running swiftly or even tumbling upon them from waterfalls. It differs from other Stone-flies in having no tails (cerci).

The British genera are *Dictyopteryx*, *Perla*, *Isogenus*, *Chloroperla*, *Capnia*, *Tæniopteryx*, *Leuctra*, and *Nemoura*.

The sub-order Psocidæ, so far as this country is concerned, consists of the Psocids, but in other parts of the world the White Ants or Termitidæ would be put forward as characteristic. Our own few species (about thirty) are the minute soft-bodied Dust-lice one comes across out of doors when hunting for fungi and Insects among decayed wood, loose bark, etc. Few people take any notice of these, but a similar indoor species is known as the Book-louse (*Atropos divinatoria*) from its frequent appearance in old and little read books. If looked for it would be found in plenty among any kind of household lumber and refuse, and sometimes it contrives to get into the collections of the entomologist and the botanist, creating havoc by its steady nibbling at the most treasured specimens. It is a dirty white, semi-transparent morsel, about a tenth of an inch in length, with a big head, a pair of long, delicate antennæ, no wings, and showing two divisions of the fore-body—the second and third being amalgamated. The thighs of all the legs are stout in comparison to the shanks, and especially is this so in the hind pair of legs whose thighs are relatively huge. The hind-body is large, and in shape an almost equal-ended oval. It advertises the fact that the Book-louse is never on short rations. As this Insect never develops wings, its life appears to be one of continued activity, without change of

form, though there is, of course, an increase of size. A closely allied Insect, *Clothilla pulsatoria*, which is found under similar conditions, does possess the vestiges of wings in the form of a single pair of leathery flaps of small size. The outdoor Bark-lice (*Psocus*) in most cases develop usable wings. A remarkable habit attributed to *Atropos* is the production of a ticking noise, presumably a sex-call. A circumstantial account was presented to the Royal Society by the Rev. W. Derham so long ago as the year 1701, but more recently doubt has been thrown upon the matter, possibly by persons with a less keen sense of hearing. As the result of some investigations made many years ago, the present writer is of opinion that Derham was right. The principal difficulty with the sceptics appears to be that the only hard parts *Atropos* possesses are its jaws; but there are other means of making a noise than by stamping your feet or beating your head on the floor. It is possible that some stridulating organ exists which has not yet been observed.

The species of Bark-lice (*Psocus*) are found usually upon the trunks of trees, and when noticed at all are confused with Plant-lice (*Aphis*). We have a number of species, but from their small size their identification is not an easy matter. So far as known they inflict no damage upon the plants they frequent, neither sucking the plant's juices nor eating the leaves, but satisfying their bodily needs with dead and dry matter that nobody wants. They are so small and so fragile, and shrivel so much after death that study of them as living Insects becomes a necessity. Even in this condition identification is difficult owing to sexual differences and colour variation having led to the chronicling of species that are not species. As in the Stone-

flies, the progress of the individual from the egg to the adult is gradual, so that there is no well-marked or abrupt metamorphosis. The eggs may often be found in small batches on the under sides of leaves, when our attention may be attracted by the light reflected from the slight web of silvery tissue with which they are covered, but which does not serve to hide them. It is presumed that the female so covers them for protection against some crawling marauder to whom these minute dainties would be a feast; and who would be impeded by this fairy wire-entanglement. Most of the eggs in the batch shown *in situ* on plate 32 have hatched. They were on a bramble leaf, and were photographed with a magnification of four diameters.

The third division of the Platyptera—the Mallophaga—consists of the Biting-lice, so called to distinguish them from the True Lice, which are blood-suckers. They are all wingless, have a depressed body, with a big head and short antennæ of only three, four or five joints. The eyes are degraded or entirely wanting. The jaws are sharply toothed. The name Mallophaga expresses well their habits. It means “fleece-eaters”; and all the members are epizoid—not parasites as it is customary to describe them, for they scarcely live at the expense of their hosts but on waste and worn-out matters that encumber the natural action of the skin. They are more scavengers than parasites, feeding on skin secretions, hair and feather debris. They have no instruments for piercing the skin or sucking blood. There is no transformation, the young differing from the adult in size only. There are two families: Liotheidæ and Philopteridæ. In the first the species are active, and in the event of the death of their host they are able to move off and find other accommodation; but those of the

Philopteridæ are incapable of travelling, and when their host dies they die upon it.

One of the best known of the group is the Fowl-louse (*Menopon pallidum*) which often covers the hands of those who pluck fowls for the table; and those who tend the living fowl are well acquainted with them. Other species affect the pheasant, partridge and quail. *Trinotum luridum* is found on all species of the duck tribe, including the domestic forms. *Docophorus cygni* restricts its attentions to swans. The common fowl also harbours *Goniocotes hologaster*, *Lipeurus variabilis* and other species. The genus *Trichodectes* prefers hair to feathers, and so we find *T. latus* on the dog, *T. sphærocephalus* on the sheep, *T. equi* on the horse and ass, *T. scalaris* on cattle, and *T. similis* on red deer.

Concerning these small parasites, Dr J. Waterston, of the Natural History Museum, has made an interesting discovery recently. In the crops of various species he has found minute particles of hard minerals, such as quartz, felspar and mica, which appear to serve the same purpose as do the stones found in the crops of birds—to help break down the harder constituents of the food eaten.

THRIPS

THRIPS, like Green-fly, are among the chief bug-bears of the gardener, and it is to be feared that they receive greater attention from him than they do from the naturalist. There is, however, this difference, that the few naturalists who have devoted special attention to the order Thysanoptera have been keen on elucidating the facts of the 'Thrips' life and structure, the others have been more intent upon wiping out what they regard rightly as a pest. In the latter attitude there is always a danger of righteous indignation loading the accused with crimes he is incapable of committing, however well-inclined to them he may be; and so we may read in gardening works of reference that the villainous Thrips *gnaws* off the young shoots and tender foliage.

Thrips are long, slender-bodied Insects of a dark colour, with four narrow wings, made to appear wider by fringes of long hairs on one margin or both back and front. The head is long and flattened, with a pair of compound eyes and usually three simple eyes. The antennæ as a rule are rather short, and consist of from six to nine joints. The mouth-parts are adapted for piercing vegetable tissues and sucking the juices therefrom: they differ in structure from those of all other Insects. The legs are short, and the foot ends in a little bladder which bears a claw on each side. The young resemble the adult, except that they have no wings. Before these are assumed the nymph

becomes sluggish and fasts, enclosed in a film. These minute creatures, which may be as little as a fiftieth of an inch in length, but more usually perhaps about a twelfth of an inch, are abundant everywhere on leaves, flowers, grass, and bark. Comparatively few species have been determined, only fifty British; but it is probable that a fine field for investigation lies open here. They are reported frequently as inflicting great damage to greenhouse plants, but here fumigation might be carried out easily to get rid of the trouble. It is very different when millions of them attack a standing crop of corn or oats and suck the grain in its milky stage. Peas and beans also suffer from their attacks; and they have been reported in official publications as seriously damaging the fruit of pears.

WINGLESS INSECTS

WE have already dealt with several cases of Insects possessing no means of flight; but we have now to deal with an entire order—the Aptera—of which the outstanding character is a complete absence of even the rudiments of organs of flight. They are all minute Insects, found on the earth, under clods, loose bark, decaying wood, and anywhere that decaying vegetable matter may be found; some even on the surface of pools, whether of fresh or salt water. The order is divided into two sub-orders, Thysanura and Collembola, as the families grouped under one have characters that distinguish them from the others. One of these may be mentioned now as a rough and ready means of relegating an Insect to its proper group: the Thysanura have long antennæ consisting of many joints, whilst the Collembola antennæ, whether long or short, have very few joints. Some species are covered with scales, others have none.

Taking these in order: the Thysanura or Bristle-tails have ten segments to the hind-body, the last one bearing a pair of antenna-like cercopods of many joints. They may have either simple or compound eyes, but *Campodea* has neither. The legs end in distinct feet of several joints; and in addition to the usual three pairs of jointed legs they have on the hind-body several pairs of unjointed limbs. *Campodea staphylinus* is the long, slender, and delicate white Insect that is abundant on loose earth and damp decaying wood, that appears to

have antennæ at both ends. Including these appendages, its entire length is only a quarter of an inch. Although it has no eyes, it appears to be very sensitive to light and at once seeks cover when exposed. The head is round, and the mouth-parts are sunk into it. The three segments of the fore-body are quite distinct, and each bears a pair of spiracles or breathing pores. There are unjointed limbs on the under side of the second to seventh segments of the hind-body. It is extremely difficult to secure specimens of this Insect because of its exceeding brittleness; the most promising method is to induce it to walk into a glass tube previously provided with a slip of damp blotting paper—otherwise it will become desiccated in the dry air. A more familiar Insect, because it lives in many of our houses, is the Silver-fish Insect (*Lepisma saccharina*), the lively fish-shaped pest clad in silver scales that is so fond of sugar and starch that it is accused of eating holes in starched fabrics such as window curtains. It is happy if it comes upon a little spilled sugar in the housewife's store cupboard. It has a small head with a pair of long antennæ, a broad fore-body from which the hind-body tapers to its extremity where, in addition to the pair of cercopods such as *Campodea* has, there is a third appendage in the middle line. There can be little doubt that, like the Cockroach, the Silver-fish is an alien, as it is only found in our houses to which it has been introduced with goods from abroad. Its eyes are a compromise between simple and compound, for there are two loosely compacted heaps of about a dozen facets. A closely related Insect, but of different colour, is the Fire-brat (*Thermobia furnorum*), that is sometimes found in swarms about bakers' ovens, whence it sallies into the kneading troughs and flour stores,

flour being its principal food. The Bronze-fish (*Machilis maritima*), of a mottled metallic brown tint, may be found on rocky coasts lurking under seaweeds. It has large compound eyes on the top of the head, meeting in the centre, and there is a single simple eye in front of each of the others. Like the Silver-fish it has a central tail as well as the pair of cercopods. *Machilis polypada*, our only other species, is found among dead leaves in the New Forest. It has both silver and brown scales which produce a mottled effect.

The Collembola, in addition to the few jointed antennæ, are distinguished by having just six segments to the hind-body, of which the fourth segment may be considerably longer than the others. On the basal segment underneath there is a curious tube which may possibly be used in walking or for breathing, it is not certain which. On the fourth or fifth segment there is a peculiar forked organ, of which each of the two prongs or teeth ends in a club or claw. By the sudden extension of this organ the Insect leaps into the air. There are no compound eyes; and the simple eyes vary in different species from one to eight. The jaws are sunk in the head; and there are no joints to the foot, the claws of which alone it consists being attached to the end of the shank. The body may be covered either with hairs or with flat scales. They may be found on damp earth, among moss or under bark, but a damp atmosphere is essential to them; given this they appear to be able to stand extremes of temperature. There are three families represented in Britain: Smynthuridæ, Lipuridæ and Poduridæ.

The Smynthuridæ consists of the genera *Smynthurus* and *Papirius*. They have no scales, and the segments of the somewhat globular bodies are

partly fused together. The antennæ are elbowed; and there is a system of respiratory tubes which have openings just behind each antenna. *Smynthurus fuscus*, our largest species, is about a tenth of an inch in length, and brown in colour. It is common under damp wood and bark, where it appears to feed on fungoid material. *Smynthurus viridis*, another common species, is, as its name indicates, green; and *S. luteus* yellow.

The Lipuridæ have more elongate, distinctly segmented bodies, with the short antennæ not elbowed. They do not leap, having no spring. They are very small and move slowly. *Lipura fimetaria* is soft, white, and velvety, and found in abundance on damp earth and rubbish heaps. *L. maritima* is lead coloured, and affects the surface of rock pools and occurs generally about the rocks on the sea coast between tide marks, merely taking refuge in rock crevices when the tide rises and covers them.

The Poduridæ has a good representative in the familiar short blue-black *Podura aquatica* that is frequent on standing water anywhere.

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